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THE MONIST

A Quarterly Magazine

Devoted to the Philosophy of Science.

Editor: DR. PAUL CARUS. *Associates:* E. C. HEGELER. MARY CARUS.

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(For particulars see inside title-page.)

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JEAN JACQUES ROUSSEAU, A FORERUNNER OF PRAGMATISM.

I DEFINE pragmatism as a philosophy that judges of the value of theories and ideas from their consequences, i. e., from the practical results which they yield to the thinker when he proceeds to apply them to reality.

Pragmatic results may be understood as scientific results; but in this case it becomes obvious that pragmatism is only another word for science, and hardly worth while to retain our attention. Of course we consider, and man has always considered, true or satisfactory, a law or an idea which yields results, and none else; and if a law or an idea explains nothing or accounts for nothing, it is given up. So this scientific pragmatism is not, cannot be, what pragmatists have in mind, for they would not have started a new philosophical school to say something that nobody ever denied, the very thing and the only thing which all scientific, philosophical, theological minds have always agreed upon since the dawn of conscious thinking. Of course William James says, "a new name for an old thing"; still we have too high an opinion of Professor James and others who followed him to believe that the "old thing" was the commonplace truth which the world has owned so long, and which science in our epoch is applying so frantically everywhere. Or else, one might just as well start a new

system of astronomy to prove that the sun shines at noon and remains invisible at night.

There is only one alternative: if pragmatic results do not mean *scientific* results, they must mean practical results from the point of view of "practical reason" as opposed to "pure reason," in other words, ethical results. And if this is what pragmatism means, then everybody will grant that there is something relatively new in it, in so far as there was never before so bold an attempt to reduce philosophy to moral philosophy; or, I should rather say, that never an attempt could appear so bold, as we live in a scientific era when scientific results alone are strictly recognized by scholars, while ethical or esthetic preoccupations are considered among them as intruding elements.

So the whole quarrel about pragmatism originates from the vagueness of the word "result," or "practical value"; the pragmatists endeavoring to make modern philosophy adopt ethical pragmatism instead of scientific pragmatism; and as they are entirely different things, as they are in fact incompatible things, scholars resist the attempt.[1] With this conception also the word of James, "a new name for an old thing," gets a very satisfactory meaning; namely, that man has always been inclined to judge philosophical theories from their ethical results. Pragmatism is only the philosophy which tries to establish this conception of things on a systematic basis, to justify this natural inclination.

It is of this ethical pragmatism—the only one which has a clear and distinct meaning—that Rousseau is a forerunner.[2]

[1] See the writer's *Anti-pragmatisme* (Paris, 1909) pp. 26-37.

[2] The words *pragmatisme*, or *pragmatique*, are of course not to be found in Rousseau. In *Nouvelle Heloïse* (II, 5) he speaks of Julie's father saying: "*Sa fille lui est moins chère que la Pragmatique*"; but here the political act of Charles VI of Austria is meant by which (1713) this emperor assured the throne to Marie-Thérèse as his successor.

I.

It might be interesting, and I think very relevant, to point out first a remarkable symmetry in the philosophical evolution of Rousseau and James, the latter being by far the chief representative of pragmatism; there can be no doubt that without him the movement would have been still-born.

We observe that both thinkers came to pragmatic ideas after a period of enthusiasm for pure science. James began by studying natural sciences; he took an M. D., and at first taught anatomy at Harvard University. Then he went over to psychology and wrote his most famous work, and finally he produced his pragmatistic papers and books. These facts can be interpreted thus: When he began to look at things for himself and reflect on them, James was at first interested in the universe in a purely objective way; he looked at it as a product which he liked to study in a perfectly impersonal manner. Then, secondly, he saw that the world was still more interesting when viewed from a human standpoint, from the psychological standpoint—moreover man cannot view it from any other point of view, absolute truth is outside of our means of perception; then he wrote his great work, *Psychology*. And third he came to the conclusion that man had an interest in the world not only from a human, in the sense of a psychological, standpoint, but from an ethical, or may be religious standpoint, as well. Man does not only study life, he lives it, he has a practical interest in it; then he wrote *Pragmatism*.

Rousseau's philosophical evolution describes exactly the same curve. Everybody remembers in the *Confessions* what he tells of his reading in mathematics, physics, chemistry and so forth, when living with Madame de Warens;[3]

[3] See especially Book VI. Cf. also Ritter: *Famille et jeunesse de J. J. Rousseau*, pp. 219 ff.

and especially the delightful scene when he is accused of necromancy by passers-by who see him in a garden at midnight studying astronomy in grotesque attire, moving a telescope backward and forward with mysterious gestures, and stretched out before, or rather under, a map of the sky illuminated by the weird light of a candle standing in a flower pot;[4] or the account of how he nearly blinded himself for life by careless handling of chemical substances in an unfortunate attempt to manufacture *"encre de sympathie"*;[5] or again when he tells himself so charmingly (always in the *Confessions*) that his famous *polype au coeur* which disappeared so miraculously before he came near the doctor, when a pretty woman appeared on the scene,[6] was nothing but the result of overstudy of books on anatomy, physiology and medicine; for, like the famous Dutch physician he could not read the description of a disease without at once feeling perfectly satisfied that he was suffering from it. Finally I need not insist on Rousseau's fondness for botany which first developed at that period also.[7]

Rousseau did not teach sciences, as Professor James, but he made use of his knowledge in mathematics as a member of the staff entrusted by Charles Emanuel III with the survey of the kingdom of Savoy. He also wrote in Chambéry in 1738, and published in the *Mercure de France* of July, a *"Mémoire sur la sphéricité de la terre."* Better still, Rousseau wrote in Paris, probably about 1747, a treatise on chemistry in four parts, *Les institutions chymiques,* the manuscripts of which can be seen since 1904 at the city library in Geneva.

[4] *Œuvres,* VIII, 171-2.

[5] *Œuvres,* VIII, 155. That the rumor spread of Rousseau's experiments, see Ritter, *Famille et jeunesse de J. J. Rousseau* (1896), p. 221.

[6] *Œuvres, VIII,* pp. 177-8: "...Voilà Mme. de Larnage qui m'entreprend; et adieu le pauvre Jean-Jacques, ou plutôt adieu le fièvre, les vapeurs, le polype...."

[7] *Œuvres,* VIII, p. 128.

II.

The second period of Rousseau's philosophical development corresponds to that in which James wrote his *Psychology*. Now, we must remember that in his book James has given up the traditional treatment of the three faculties, sentiment, intelligence, will. He offers a sort of natural history of our mental faculties in connection with, or even taking as a basis, our sensations, hence the name of "experimental" or "physiological" psychology given to the modern science we all know.

This conception of things goes naturally as far back as the 18th century, to Locke's *Essay on Human Understanding*. Indeed we can almost say that the works of our great thinkers of the 19th century, like John Stuart Mill in his *Logic*, Taine in his *Intelligence*, Wundt, Spencer, James in their *Psychologies*, are but new additions, broader in some places, more consistent in others, of Locke's epoch-making book. As a matter of fact, nobody ever went so far in the direction of sensualism and materialism as does James in his well-known theory of emotions, according to which we do not weep because we are sad, but we are sad because we weep, the physical phenomenon not being the effect of the psychical one, but rather the reverse.

Rousseau, thanks in great part no doubt to his unsystematic education, was endowed with a very unprejudiced mind, and he did not hesitate to adopt those views which were held at the time only by a few progressive men; Locke's ideas on this particular subject soon became his own,[8] and we can easily see how they came to him. He tells us in the *Confessions* that in the years after his return from Venice to Paris (1744) he had become a great friend of

[8] He had already studied Locke at the Charmettes. See *Œuvres*, VIII, p. 169.

Condillac, then writing his famous books.[9] He calls him once "*un très grand métaphysicien.*"[10] Although Rousseau never went as far as Condillac in the latter's *Traité des sensations* (1754), namely that the only origin of all our ideas is sensation alone, he shared entirely the views of the earlier *Essai sur l'origine des connaissances humaines* (1746), that there are no innate ideas and that our ideas, due to reflection, would never have developed without sensation—the Locke point of view. Rousseau remained true to those beliefs in the time of his mature philosophy; in *Emile*[11] for instance, and in the much later *Dialogues*[12] we find them again only slightly transformed. It would be quite interesting to point out the influence of those physiological-psychological views on Rousseau in several special works, especially in the *Essai sur l'origine des langues*, which was written under the inspiration of Condillac's ideas;[13] and in a book which has not been printed, the manuscript of it being probably lost for ever, *La morale sensitive ou le matérialisme du sage.*

Students of Rousseau, generally, ignore this work entirely, and it is pardonable as long as it is lost. But a great loss indeed it is, for surely no work could have given us a better insight into Rousseau's real mind, precisely because it belongs to a period of transition, when he is not yet completely the Rousseau of the *Nouvelle Héloïse* or of *Emile*. We would have seen there how he became the later Rousseau, while now we have to guess more or less. Fortunately the little bit we know about the book, we owe

[9] *Œuvres*, VIII, p. 246. Rousseau places this in the years 1747-49, but this must be a mistake since the book of Condillac mentioned by Rousseau was published in 1746.

[10] *Œuvres*, XII, p. 304; cf. II, 75.

[11] See Books I, II, III, *Œuvres*, II, e. g., pp. 32-33, 102, 188 etc.

[12] *Œuvres*, IX, 196.

[13] Cf. *Œuvres*, I, p. 93.

to Rousseau himself, and so the information may be relied upon.[14]

What was this book? Rousseau tells us that among the works he intended to write—and which later were given up—there was one which he hoped would prove truly useful to men. "We have noticed that in the course of their lives most men are unlike themselves and seem to be changed into beings entirely different. It was not indeed to prove so well known a thing that I proposed to write a book; I had a more important and newer purpose. It was to find out about the causes of those variations, and to study those which are dependent on us in order to show how they could be directed by ourselves in order to render us better and exert more control over our actions.... In probing myself, and in examining others as to the causes of those different dispositions I found that they depended in great part, on the preceding impressions of exterior objects, and that, modified constantly by our senses and by our organs, we were feeling, without knowing it, in our ideas, in our sentiments, in our actions even, the effect of those modifications. The striking and numerous observations which I had gathered were beyond discussion; and by their physical principles, they seemed to me fit to provide us with a physical régime which, adapted to circumstances, could place our souls in the conditions most favorable to virtue.... Climates, seasons, sounds, colors, darkness, light, elements[?], food, noise, silence, motion, rest, everything acts on our machine, and on our soul consequently..... I have however, worked little over that book, the title of which was *La morale sensitive ou le matérialisme du sage*. Distractions which I shall soon explain prevented me from devoting much time to it, and the

[14] There is an interesting problem of erudition in connection with the *Morale sensitive*; but the discussion of it belongs rather in a review for the history of literature. Suffice it to say that further information about the book is not attainable, at least now, and that all that is reliable goes back to what Rousseau says himself in the *Confessions*.

reader will know also what has become of my first draft...." This passage is from the ninth book of the *Confessions* (pp. 292-3). In book twelve (pp. 46-7) he tells of all sorts of papers that were stolen from the things he had left in care of Madame de Luxembourg at the time of his hasty flight to Switzerland, when the *Emile* had been condemned. Among the stolen papers was the manuscript of the *Morale sensitive*, and Rousseau suspects D'Alembert, who, as a friend of Madame de Luxembourg may have succeeded in seeing those manuscripts, perhaps by bribing some servant.[15] At that time Rousseau considered D'Alembert as one of his worst enemies, and comments thus: "I suppose that, deceived by the title of *La morale sensitive*, he thought he had discovered the outline of a real treatise of materialism, from which he would have taken an advantage against me that one might well imagine."[16]

One may well ask why Rousseau did not take up his work again. I think we can guess that, and the very note we have just quoted about D'Alembert could suggest a clue. Such a book was not only difficult to write, it might prove positively dangerous. For in conveying upon people the materialistic idea that the dispositions of our "soul" depended ultimately so much upon physical sensations, as comparatively very few (if any) of those are actually within our control, people might take that as an excuse for not reacting against the lower impulses of the flesh. Thus the book could be interpreted as an excuse for our weaknesses, instead of a remedy against them, and so would provide arms to the enemy, and throw one's own away.

[15] In a note (Vol. XII, p. 47) Rousseau explains that D'Alembert had plagiarized many of his articles before they were printed in the *Encyclopédie* (for the *Elémens de musique*).

[16] One feels inclined to reject such ungenerous suspicions. Still, after the book of Mrs. Macdonald which shows how really shamefully Rousseau was treated by some of his contemporaries, there is a possibility of truth. So, if we should ever get some parts of the *Morale sensitive* back, it might be in looking into D'Alembert. The search may be worth while—the writer not having at hand the books necessary for such an inquiry is obliged to confine himself to these indications.

Madame de Genlis would certainly not have been the only one to gather from Rousseau's notes the impression which Rousseau himself thought might be D'Alembert's. She reflects: "I never thought that virtue depended upon good digestion or on the temperature of the air, or that certain drinks could cure bad inclinations, and that it was possible to absorb morality, like tea, by infusion."[17]

The insurmountable difficulty is, of course, that there is absolutely no criterion to decide where to stop in admitting that physical conditions are responsible for our morality. You cannot at one moment step in and say: "Now I will be virtuous" without throwing over the whole theory. For, this sudden disposition depends precisely upon foregoing dispositions, and those form an endless chain. Suppose a meal is so made up as not to develop my lower passions; either I am responsible for the meal or another is. If another is, then it is clear that my temper is not in my own hands. If I am, then I must have been predisposed well in order to order the virtuous meal; so from antecedent to antecedent, we are bound to come to admit that we are no longer responsible for anything. The same holds of climate, wind, rest, noise, etc.... What can I do? There is no middle term: we are or we are not in control. You may leave the subject alone altogether,—which is very wise perhaps,—but if you take it up, then you must be logical.

Rousseau chose to say that the dispositions of our soul depend upon material conditions; the result is that he will tell us very interesting facts probably, but surely none very favorable to moralization. And the time came when he saw it himself, and therefore he dropped the book. I venture to say that if he had written it, he would have torn it to pieces afterwards.[18] The time when he was thinking

[17] *Préface à Alphonsine*, p. iii.

[18] The book Rousseau had in mind *has been written*; but a century later. Those who are interested to see what a consistent treatise of the sort may be-

of writing it indicates a period of unconscious hesitation between the scientific or psychological point of view, and the ethical or pragmatic. He was then just where James stood when he printed his *Psychology*, and which after a long discussion of the book is expressed for the French public by Marillier in the following terms: "The teleological character of the system is at first striking, and one must penetrate beyond the literal sense to notice that very often it is a selection of a mechanical character much rather than of an intentional choice that is meant. This W. James says clearly nowhere; perhaps not because he is not decided yet which one of the two conceptions he will make his own, but because he constantly goes from the one to the other without admitting it plainly." (*Revue philosophique*, Feb., 1893, p. 182,)

III.

James finally decided for a teleological system, or what is now often called—a new name for an old thing—pragmatism. I have shown elsewhere, in quoting texts, how pragmatic utterances had meant at first for James simply a set of rules for practical life, *independent* and really *outside* of philosophy, and how only gradually the idea came to him of introducing those merely practical advices into philosophy itself, and trying to subordinate intellectual and scientific principles to practical principles.[19] The result is that his philosophy now, pragmatic philosophy, is described by James himself in such sentences as: *"The 'true,' to put it very briefly, is only the expedient in the way of our thinking, just as the 'right' is only the expedient in the way of our behaving."* (*Pragmatism*, p. 222);[20] or "On prag-

come ought to read: Yves Guyot, *La morale*, Paris, 1883 (in the collection *Bibliothèque matérialiste*).

[19] A. Schinz, *Anti-pragmatisme*, Paris, 1909, pp. 52-54.

[20] What James says regarding this passage in the *Journal of Philosophy* of December, 1908, does not affect the case very much.

matic principles we cannot reject any hypothesis if consequences useful to life flow from it....They [universal conceptions] have....no meaning and no reality if they have no use. But if they have any use, they have that amount of meaning." (*Ibid.*, p. 273.) (Of course we must understand that in the second part of the quotation, James means also "useful *to life,*" as nothing indicates any change to "useful" in a merely scientific sense); or let us recall the pragmatic "question": "Grant an idea or belief to be true, what concrete difference will its being true make in any one's actual life?" (*Ibid.*, p. 200.) This is plainly making philosophy a servant to ethics. *Philosophia ancilla theologiae* was the definition of scholasticism; *Philosophia ancilla ethicae* is the definition of pragmatism.

Now let us see Rousseau reaching the same goal.

Exactly parallel to James's phrase: "On pragmatic principles, we cannot reject any hypothesis if consequences useful to life flow from it," is Rousseau's declaration at the end of his career, when he summarizes his philosophical and literary creed, and writes, speaking of himself (Second Dialogue[21]): "I have never seen him listen calmly to any theory that he believed harmful to the public weal." (Je ne l'ai jamais vu écouter de sang froid toute doctrine qu'il crût nuisible au bien public).

As was to be the case with William James one century and a half later, Rousseau had really never committed himself to a mechanical conception of life; he had only, for a while, used such language and studied problems in such a fashion that readers could hesitate as to his real opinion on those questions. So when he had once decided to publicly take a stand against such mechanical theories of life, he felt like dispelling any uncertainty in the public, and missed few occasions to come out openly against the materialism of his epoch. He did so repeatedly in his best-known

[21] *Œuvres*, IX, p. 194.

works. Let us take only one example, which is not so well known.

In 1758 he wanted to write a complete and systematic refutation of Helvetius's book *De l'esprit*. He finally gave it up, because the work in question was condemned by the censor shortly after its publication and the sale of it was prohibited.[22] But we have the marginal notes put by Rousseau to his edition of Helvetius's book, and they give us a very clear idea of what Rousseau wanted to prove. They are published in the *Œuvres complètes*, XII, pp. 296-304. Helvetius maintained that man is merely passive in his judgments, in his sentiments and actions. This irritated Rousseau and he refers finally to a refutation in the *Profession de foi du Vicaire savoyard*.[23]

To Helvetius who thinks that two (passive) faculties, sensation and memory, are sufficient to account for our whole mental activity, and that *comparer* and *juger* are merely other forms of sensation, Rousseau opposes that, already in comparison due to memory there is something more than mere passive sensation of difference; and as to the distinction between sensation and judgment, he expresses it thus:[24] "To perceive objects is sensation; to perceive relations is judgment" (*Apercevoir les objets c'est sentir, apercevoir les rapports c'est juger*).

The whole discussion is summed up and concluded in the *Profession de foi du Vicaire savoyard* as follows: "Thus

[22] *Œuvres*, III, 122.

[23] There is here again a small problem of erudition. We must believe that the notes on *De l'esprit* are made on the first edition, as Rousseau expressly states it in a letter (cf. *Œuvres*, Vol. IX, p. 418); but, as the first edition was of 1758, and the *Vicaire savoyard* is of 1761 or 1762, how could Rousseau refer in 1758 to a work published three or four years later (p. 304)? The whole problem of the relations of the *Profession de foi du Vicaire savoyard* and the *Réfutation du livre de l'esprit* will be examined by the writer elsewhere; let it suffice here to say that a solution is not impossible if one weighs carefully every word of Rousseau in XII, 304. No doubt Rousseau was at the time (1758) already busy with the *Profession de foi*; possibly a good part of it was more or less ready, and thus he could speak of it as of a work in existence although not yet before the eyes of the public.

[24] *Œuvres*, XII, p. 300.

I am not merely a sensitive and passive being, but an active and intelligent being, and no matter what philosophers say, I dare pretend to the honor of thinking. I know only that truth is in the things and not in my mind which judges them (*que la vérité est dans les choses et non pas dans mon esprit qui les juge*) and that the less I put of my own in my judgments about them, the surer I am to come near the truth: thus my rule, to listen to sentiment more than to reason, is supported by reason itself."

Why is Rousseau so much concerned with those theories?—The last passage quoted tells it plainly: if human judgment is merely passive, the same will be true of our emotions, of our wills which depend on our perceptions and judgments of things; if that were true, it would do away with moral freedom, and this would be very bad from an ethical point of view. That this is the attitude of Rousseau is shown in the second part of his refutation of Helvetius, one of his last remarks being: "In the first place uprightness is indispensable, and not intellect (*l'esprit*); and in the second place it depends upon us to be honest people, and not to be *gens d'esprit*" (XII, 304); it is shown abundently further in all his best known works.

Rousseau is determined to get a philosophy of an ethical nature, i. e., a philosophy which must be good *morally* for humanity, even at the expense of truth if need be; he will refuse to consider any other as he himself told us.[25] As a matter of fact, nature, life and therefore philosophy are neither moral nor immoral, they are indifferent, or as we say now a-moral; but I repeat it once more, this is just the distinctive character of pragmatism that it would force nature and life, and therefore philosophy, to be moral, or, as some say, teleological,—the latter term meaning again "morally" teleological, it goes without saying. Of course,

[25] *Œuvres*, IX, 194, quoted above, and cf. with James's *Will to Believe*, p. 126.

if nature, and therefore objective truth, on the one hand and morality on the other hand agreed with each other, philosophy would never have been anything else but pragmatic, it would be so naturally. But as they do not agree, a special philosophy, different from natural philosophy, was to be founded in order to carry through pragmatic, i. e., non-natural philosophical principles. Pragmatic philosophy is therefore, cannot be anything but, unobjective philosophy, superposed over objective philosophy.

On the other hand, all philosophy to be acceptable must look objective and natural, and so of course pragmatic philosophy will have to claim that it is natural philosophy. And as it is not it will have to try to make us believe that it is: therefore, *to create a confusion between a natural or objective philosophy, and a non-natural philosophy is the very aim pragmatic philosophers will have to pursue.* If they do not do it, if they do not conceal that natural philosophy and pragmatic philosophy do not naturally agree, their cause is lost.

Thus the success of pragmatic philosophers, like Rousseau and James, depends upon their cleverness to confuse things; and indeed they have made it hard for their opponents to disentangle the fallacies of pragmatism. Philosophers ought never to cut Gordian knots, let me try to untie smoothly Rousseau's knot. The whole matter is contained in the last passage quoted.

To reduce philosophy to pragmatic or moral philosophy, two things are necessary:

1. to prove that we are not mere automata, that we can be really moral, i. e., active.
2. to prove that our natural way of thinking is pragmatic or moral, not intellectual; that therefore moral thinking is not merely a special application of pure thinking, of rational thinking, but is thinking itself.

Thus, the two adversaries to be fought will be *sensualism* and *rationalism.*

First, Rousseau forms an alliance with rationalism to defeat sensualism, thus establishing that human beings actually think; that the way in which they think does not depend exclusively on the data of the senses.

Secondly, that once established, Rousseau suddenly turns against rationalism, and says that thinking is bad. He means, of course, mere thinking, thinking which is not "morally" colored. As morality is the goal, any thinking that is not "moral" is bad, therefore the less one thinks, i. e., thinks merely rationally, the better.

Let us now read over the little paragraph quoted and analyze it and see whether I have betrayed Rousseau's thought.

First he says: *"I dare pretend to the honor of thinking."*

But he adds immediately: *"I know only that truth is in the things and not in my mind which judges them, and that the less I put of my own in my judgments about them, the surer I am to come near the truth: thus my rule to listen to sentiment rather than to reason is supported by reason itself."*

The "only" between parts 1 and 2 is a very innocent looking word; as a matter of fact, there is the most remarkable opposition between the two statements connected by it.

The first says: I think; I am not only passive but active in my judgments; I must think, otherwise I am not free and there is no morality possible.

The second says: The more I think, the further away I go from truth; I must *not* think, otherwise I get away from sound moral thinking.

Thus: *first,* I must think (to be free); *second,* I must not think (to be right).

There seems to be another contradiction in Rousseau's

attitude towards sensualism and rationalism. Regarding the first he said: Let us not admit that we are passive in our judgments; and regarding the second: Let us rather be passive in our judgments. But never mind the paradox. What he is aiming at all the time, is plainly indicated by the last sentence of the little paragraph under consideration where he opposes *sentiment* to *reason*. He means that we ought not to be affected by intellectual or rational judgments; we must not think intellectually. In other words *he admits the existence of other judgments, besides intellectual judgments.*

What are those other judgments, suddenly and surreptitiously thrown in the discussion?—Well, the sentimental judgments, which Rousseau seems to avoid to name, are the moral or pragmatic judgments. But why this fear of speaking plainly, of expressing openly the principles which are at the bottom of his whole philosophy and of momentous works like *Emile* and all the others? Simply because Rousseau felt very well that this move, of the admission of different sorts of judgments, though clever for his purpose, could not stand the test of critical examination. To judge, which implies to think, cannot *not* be intellectual, and so either to think and judge morally is one and the same thing as to think or judge intellectually, or it is not; and then to judge morally is to judge non-intellectually or irrationally (or a-rationally, that makes no difference.) Now, as Rousseau plainly suggests two kinds of judgments, (*a*) sentimental and (*b*) rational or intellectual, there is no way out of it, the sentimental must not be rational. There would be no use distinguishing them if they were alike.

We come now to the next question. As Rousseau puts those irrational judgments at the basis of his philosophy, refers to them all the time, they must of course correspond to something definite. What is it? What is *practical reason* as opposed to *pure reason* (—for, this is the oppo-

sition which Rousseau establishes and which Kant named so conveniently)?—Back of this famous word, *practical reason*, lies the whole secret of the pragmatic fallacy.

When you judge or think, you always judge intellectually or rationally, there is no escape from that; but it is possible when judging intellectually to judge either objectively or subjectively; and now we see at once how "practical reason" can still remain "reason." You have pure reason and applied reason, pure philosophy and applied philosophy, as you have pure science and applied science. As a mathematician gives up pure mathematics for astronomy, or a chemist gives up pure chemistry for confection of food, or a physicist gives up pure physics to manufacture telephones, so one can give up pure philosophy for applied philosophy, the most common form of which is ethics. It is still intellectual, but what was the end before, to study and to judge man, nature, life for the sake of pure science, for the sake of promoting objective truth, has become a means, i. e., one applies judgment or thought about men, nature, life to the promoting of happiness, of social order, of morality—no matter how you call it. And this applied judgment, this intellectual judgment in favor of a special end, an ethical end, is the sentimental judgment of Rousseau, or, as he calls it, simply sentiment, meaning of course moral sentiment, or moral sense.

As a matter of fact Rousseau and later pragmatism have done nothing else but to say, and try to make us believe, that this applied moral philosophy was really philosophy itself and that whatever is not moral philosophy (or does not lead to it directly or indirectly; religion e. g. in a pragmatic sense is "moral" too) is not true philosophy. But this is as if an astronomer said that of mathematics only so much is true as can be applied to astronomy; or if a food manufacturer claimed that only that much of chemistry is true which applies to "Force" or "Quaker Oats";

or if a capitalist owning a street-car line maintained that physics is true only in so far as it can move his cars along.

Keeping in mind then that "sentiment" or sentimental judgment of Rousseau is nothing else than a special application of philosophy or pure reason to ethics, let us read in its more explicit form the little sentence ending our paragraph; only two adjectives have to be supplied to betray the fallacy in logic: "My rule, to allow myself to be guided by sentiment rather than by [pure] reason is confirmed by [practical] reason itself"; or, as we have seen that the second "reason," practical reason, is the same as "sentiment," we will have: "my rule....to be guided by sentiment rather than by reason, is confirmed by sentiment (itself)"—which of course is just the opposite of the conclusion Rousseau wishes to reach; and moreover, a very transparent *petitio principii*; as if a father were going to prove his authority over his children by saying: this authority is proven because I say so. The word *itself* is absolutely illegitimate, and suggests to the reader a confusion which he could not possibly have committed if clear terms had been used, if "reason" was used consistently, and not at first as *pure* reason, and then as *practical* reason.

The fallacies just exposed are better recognizable in Dewey than in James and Rousseau. Dewey naively attempted an elaborate and painful identification of purely philosophical principles and pragmatic principles on logical grounds; I have shown in the *Journal of Philosophy* (of Nov. 16, 1908) why it was *a priori* impossible that he should succeed, and how in insisting upon logic in pragmatism, he was carried to the antipodes of pragmatism in spite of himself. James and Rousseau wisely did not insist on that part of the matter; Rousseau, as has just been seen, managed to get the whole thing in an innocent looking little bit of a paragraph where probably not one of a thousand readers will notice it—a real trick of legerdemain

(done, I need not say, with a very generous and moral purpose in view, a *pieux mensonge* as they say in Rousseau's country). James is as wise as Rousseau; he kept silent. Only once have I noticed that he faced the difficulty, and then the honesty of the man betrayed the attempts of the philosopher: for he implicitly admits that there is really no logical, no rational background to that aspect of pragmatism. This important passage is found in *Pragmatism*, when James feels cornered by an objection to pragmatic views, which he cannot help mentioning, namely: what has the teleological element to do with truth? "The essence of a sane mind, you may say, is to take shorter views, and to feel no concern about such chimeras as the latter end of the world. *Well, I can only say that if you say this you do injustice to human nature.*[26] Religious melancholy is not disposed of by a simple flourish of the word insanity. The absolute things, the last things, the overlapping things, are the truly philosophic concerns...." (p. 108). Nobody says that you must ignore those "absolute...last...overlapping things," or even that they are not more important to humanity than merely objective philosophy. But the true philosopher considers that one ought not to call objective philosophy what is merely our subjective power of reasoning.

Another passage of James may be quoted here as proof of how much the same preoccupations are at the bottom of both philosophies. I need only recall the fact that what Rousseau called sensualism is now called materialism, and what Rousseau called rationalism is now called agnosticism. Keeping this in mind read James: "Just as, within the limits of theism, some kinds [of theisms] are surviving others by reason of their greater practical rationality[!], so theism itself, by reason of its practical rationality is certain to survive all lower creeds. Materialism and agnosti-

[26] The italics are mine.

cism, even were they true, could never gain universal and popular acceptance, for they both alike give a solution of things which is irrational to the practical third of our nature ["sentimental" third of Rousseau], and in which we can never volitionally feel at home." (*The Will to Believe,* p. 126.)

For both Rousseau and James the whole problem of philosophy consists in this: identify truthfulness[27] and usefulness: you can say of a truth "either that 'it is useful because it is true,' or that 'it is true because it is useful' "; and the "usefulness" meant there is pragmatic or ethical "truthfulness," not merely "objective" or "scientific": "On pragmatic principles we can not reject any hypothesis if consequences useful to life flow from it." (*Pragm.*, p. 273; cf. 222, 233 and 234, and the whole of lectures VII and VIII.)

This *ethical* meaning is the meaning of the pragmatic "question": "Grant an idea or a belief to be true, what concrete difference will its being true make in anyone's actual life?"—or there is none.

And notice that we find this famous "pragmatic question formulated in remarkably similar terms by Rousseau. It is expressed or understood everywhere in his writings: but probably nowhere so plainly stated as in the third book of *Emile.*

In the programme laid out by him for the education of the boy, Rousseau proposes for the two first periods, from one to five, and from five to twelve years of age, a merely physical and animal development; the body and mind of the child must be let free, he must get strong and ready for work. Only when he is twelve years of age, shall Emile begin to apply his acquired strength and faculties to some definite purposes. The time has come to teach him. What shall one teach him? There are three, or rather

[27] I do not see that it makes much difference to say *truth* or *truthfuiness*; still as James insists in a special article (*Journal of Philosophy,* March 26, 1908) on that distinction I gladly insert "truthfulness."

four sorts of things, which man can learn: some are false, some useless, some proper only to develop our vanity. There are a few, however, which are worthy of a wise man: "The question is not to know what is, but only to know what is useful." (*Il ne s'agit pas de savoir ce qui est, mais seulement ce qui est utile.*) *A quoi cela est-il bon?* (What is it good for?) that, from now on, is the sacred word....the one you teach, as being his most important lesson, to desire to know nothing except the useful, ask questions like Socrates. Let me quote the few lines with which Rousseau sums up his whole book of *Emile*: "It is enough that the child should know the 'what for' (*l'à quoi bon*) of everything he does, and the 'why' of everything he believes. Once more: *my purpose is not to give him science, but to teach him how to get it in case of need, to make him appreciate it for exactly what it is worth, and to make him love truth above all.*"[28] (P. 179.)—How clear it is here that "truth" means "practical truth," "cash-value," as James says, *in opposition to* "science"!

All this, I say, is good pragmatism.

When it comes to special application of pragmatic principles the comparison holds of course. But as Rousseau has worked out the application more than the principles and James has done the reverse, it will suffice to refer the reader to the second half of the *Nouvelle Heloïse* where applications follow upon applications under Rousseau's pen. See particularly Part V, Letter 3. One instance, however, may be allowed here: the views of Rousseau and James about religion. I have treated this point at length regarding James in my book *Antipragmatisme*, p. 143 ff. I recall only one passage of *Pragmatism*: *"If theological ideas prove to have a value for concrete life, they will be true, for pragmatism, in the sense of being true for so*

[28] The italics are mine.

much."[29] Now here are two short sentences (from among hundreds) showing how Rousseau applied the pragmatic principle one and a half century ago, principles which, when applied, look much less sublime than when vested in the eloquent sentences of the *Profession de foi du Vicaire savoyard*; even here the grand style of Rousseau has dazzled most of his readers. A few years had elapsed since Saint Preux and Julie had yielded to their love; now Julie is married to Wolmar, but Saint Preux lives under the same roof as preceptor of their children. Wolmar goes away and the two former lovers remain alone: "Our hearts," writes Saint Preux, "had loved each other; they had not forgotten; and everything now seemed to unite in making us sin again." Julie was determined, however, to conquer, and "she could not imagine a more reliable precaution than to impose upon herself constantly a witness whom she would have to respect, to call, as a third one among us, the integer and redoutable Judge who sees secret actions and reads our hearts. She surrounded herself with His supreme majesty; I saw God constantly between her and me. What guilty desire could have attempted to ignore such protection?"[30]

And on the same page again, discussing the case of Wolmar who was good without religion, Rousseau puts in Saint Preux's mouth the following words: "Milord, we will never be able to convert that man; he is too cold, and he is good; the question is not to touch him [with arguments]: he lacks the interior proof of sentiment, and this is the only one which renders the others irresistible," in other words: Wolmar needs no religion, being good without it; therefore we have no way of converting him. And here

[29] James underlines.—It is true that he adds: *"For how much they are true, will depend entirely on their relations to the other truths, that also have to be acknowledged,"* but it is evident that this contradicts the first sentence flatly. If the ideas are true anyway, what is the use of pragmatism; if pragmatic ideas have the first right to be called truth, why bother about other criterions?

[30] *Œuvres*, IV, p. 416.

remember James's words in the *Will to Believe,* p. 30: "The whole defense of religion hinges upon action. If the action required or inspired by the religious hypothesis is in no way different from that dictated by the naturalistic hypothesis, then religious faith is a pure superfluity, better pruned away, and controversy about its legitimacy is a piece of idle trifling, unworthy of serious minds."[31] Rousseau said: "And if the Great Being did not exist. . . .it would still be well that man should think of him [*s'en occupât*] constantly, so as to remain better in control of himself, to be stronger, happier and wiser." (*Œuvres,* IV, p. 248.)

To sum up my whole demonstration of the parallelism of Rousseau's and James's thought, I offer the two following passages for comparison. In them, for every one who has in the least a critical sense, these two thinkers give themselves away (if I may so speak) in their attempts at pragmatizing philosophy. These two passages allow us to put our finger right on the spot where the system leaks, or, still better, go off on a tangent.

James writes in *Pragmatism,* pp. 76-77:

"If there be any life that it is really better we should lead, and if there should be any idea, which, if believed in, would help us to lead that life, then it would be really *better for us* to believe in that idea, unless, indeed, belief in it incidentally clashed with other great vital benefits. [Now listen:] 'What would be better for us to believe'! This sounds very like a definition of truth. It comes very near saying 'what we *ought* to believe': and in *that* definition none of you would find any oddity. Ought we ever not to believe what it is *better for us* to believe? And can we then keep the notion of what is better for us, and what is true for us permanently apart?" That playing with the

[31] It is true that Wolmar is not actually presented to us as sharing the "naturalistic hypothesis," but that is of no importance here; any thing that is not the "religious hypothesis" may be understood as well.

logical and the sentimental meaning of *ought,* I call the superlative of cleverness.[32]

Now to Rousseau. It is a passage from the answer to the archbishop of Paris (*Œuvres,* III, pp. 92-93), who had written his "Mandement" aginst *Emile,* speaking especially of the *Profession de foi du Vicaire savoyard.*

"It appears to me credible that, after these long periods lost in puerile controversies, men of sense will some day seek for a means of conciliation. The first thing they will propose will be to put out of the assembly all theologians [you might read just as well metaphysicians or philosophers]. This good work done, they will say to the peoples: 'So long as you do not agree upon any common principle, it is impossible for you to understand each other; and it is an argument that has never convinced any one, to say I am right and you are wrong. You speak of what is agreeable to God, but that is precisely what is in question! If we knew which creed was most agreeable to Him, there would be no dispute between us. But you also speak of what is 'useful' to men—that is a different matter. Men can decide this. Let us take this utility for our rule, and then let us establish the doctrine which is nearest to it. We may by this means hope to approach as near to the truth as is possible to men; for *we may assume*[33] that what is most useful to the creatures of His hand, is most agreeable to the Creator."

Exactly the same fundamentally: the useful, in the sense of the morally good, must be the principle of belief, philosophic or religious. The only difference in expression being due to the circumstance in which the passages were written. Rousseau proves a trifle more theological because he answers de Beaumont who attacked his pragmatism on religious grounds, and he wants to show that religious

[32] The same has been done by Schiller. See *Anti-pragmatisme,* pp. 23-24.

[33] The italics are mine.

problems are far from indifferent to him; James, on the other hand, is facing philosophers and argues with the aim of turning logicans into moralists or pragmatists.

Of the two, James is altogether more philosophical. Rousseau thinks that he can oppose a systematic and rational philosophy to the objective philosophers on the one hand, and to the dogmatic Christians on the other, namely that in the world everything is rationally and morally harmonious (*Profession de foi du Vicaire savoyard*); while James is more modest and frankly acknowledges that pragmatism requires the giving up of the ideal of unity of thought. He plunges into *pluralism* because reality refuses to be synthetized in his philosophy: "The world is One just as far as we experience it to be concatenated, One by as many definite conjunctions as appear. But then also *not* One by just as many definite *dis*junctions as we find... It is neither a universe pure and simple, nor a multiverse pure and simple." (*Pragm.*, p. 148); and he advocates *meliorism* because he cannot be an *optimist*: "It is clear that pragmatism must incline towards meliorism...."Meliorism treats salvation as neither necessary nor impossible..." (p. 286). This modesty about the shortcomings of his own philosophy is extremely praiseworthy on James's part; only as it is equivalent to saying that pragmatism does not stand the scientific test of unity of thought, it is from a philosophic point of view, simply mortal.

Our task is really over here. Still it is interesting to remark how closely the two philosophers compare, when one examines some applications of the pragmatic principles which the two men have deemed important to discuss.

Three examples may be selected:

1. For both men the ultimate purpose of pragmatic principles is to fit people for practical life as much as possible, and thus increase their general happiness. Now the danger is that if you preach happiness outright people are

likely to indulge unwisely in pleasures and thus, either to burn the candle at both ends, or to get blasé to pleasure; in both cases it means depriving themselves ultimately of good things just out of sheer ignorance or heedlessness. There was at the time of Rousseau, and there exists undoubtedly to-day, a tendency among us to overwork ourselves, so to speak, in making merry, while for purely Epicurean reasons we really ought to refrain more. Thus, both Rousseau and James insist repeatedly in their writings on a sort of asceticism which men must impose on themselves, not at all to deprive themselves, but on the contrary to get *more* enjoyment out of life in the long run, or more power of resistance against suffering. From James I quote the passage of *Psychology*, Vol. I, pp. 126-7, which he has not unfrequently developed in later works, recently in a pedagogical publication. It is found at the end of the chapter on "Habit": "As a final practical maxim, relative to these habits of the will, we may then offer some thing like this: *Keep the faculty of effort alive in you by a little gratuitous exercise every day.* That is, be systematicly ascetic or heroic in little, unnecessary point; do every day or two something for no other reason than that you would rather not do it, so that when the hour of dire need draws nigh, it may find you not unnerved and untrained to stand the test. Asceticism of this sort is like the insurance which a man pays on his house and goods. The tax does him no good at the time and possibly may never bring him a return. But if the fire *does* come, his having paid it will be his salvation from ruin. So with the man who has daily inured himself to habits of concentrated attention, energetic volition and self-denial in unnecessary things, he will stand like a tower when everything rocks around him and when his softer fellow-mortals are winnowed like chaff in the blast."

James here takes life under its severe aspect; let us select in Rousseau a few passages where the Epicurean note

is more pronounced. The author writes of the incomparable Julie: "The means she uses to give value to the smallest things is to refuse to take them twenty times, in order to enjoy them once." One of the ends she wishes to reach thus, is "to remain her own mistress, to force passions to obey, and to subordinate all her desires to the rule. It is a new way of being happy; for one enjoys without uneasiness only what one can lose without difficulty; and if true happiness belongs to the sage, it is because, of all men, he is the one from whom fortune can rob least" (*Œuvres* IV, pp. 378-9). Or again: "The privation which she imposes upon herself by this tempering voluptuousness (*cette volupté tempérante*) are both new means of pleasure, and new ways of economizing. For instance, she loves black coffee: at her mother's house she took some every day; she has given up the habit in order to get more taste for it. She has decided to have some only when guests are about, and in the salon d'Apollon, in order to add this little rejoicing to the others" (p. 286). At times it goes so far as to lack the sense of the beautiful: "When I tell her of the things they invent all the time in Paris to render the riding in carriages more comfortable, she approves of that well enough; but, when I tell her how far they have gone in improving the varnishes of the carriages, she follows me no more and will always ask, whether those beautiful varnishes will render the carriages more convenient" (p. 371).[34] Shall we say that the heroic "Roman virtues" so emphatically praised by Rousseau lose something of their lustre when brought back to that pragmatic standpoint?

2. In another point, we may call it the metaphysical meaning of life, James and Rousseau show rather striking similarity of thought. Both are anxious to secure for men the happiest and at the same time the healthiest way of living; and not only do they see that the practicing of 'vir-

[34] See also pp. 380, 384, 397 ff. etc.

tue' is by no means always accompanied by happiness, but also that people get at times impatient to wait until after death to settle their bills of rewards. So as our philosophers address everybody, and especially the masses, i. e., mostly more or less childlike people, they must find some sort of encouragement for them. They will then pat a man on the back and tell him not to be sulky at the unpleasantness of life, as we do our boys when they are reluctant to go to the dentist and we tell them: Now, you will be a good boy, you will not cry, you will be a real courageous boy. That is the meaning of James's theory of risk: man has the honor, the great honor of conquering evil, this is greatly preferable to just plain happiness; nobody would want that, would he? "Those Puritans who answered 'yes' to the question: Are you willing to be damned for God's glory? were in this objective[?] and magnanimous condition of mind" (*Pragm.*, p. 297).

Rousseau ends his *Profession de foi du Vicaire savoyard* with a few statements that remind us curiously of the last pages of *Pragmatism*: "Why is my soul dependent upon my senses and chained to this body which makes a servant of it and is a hindrance to it? I know nothing about it; did I enter into the secrets of God? But I can without impropriety propose modest suppositions. I say to myself: 'If man's mind had remained free and pure, what merit would there be to love and follow the order established in the universe and which he would have no advantage to trouble?' He would be happy, no doubt; but his happiness would not be of the most sublime kind which is the glory of virtue and a good conscience: he would be only like angels; and no doubt one day the virtuous man will count more than they do. United to a mortal body by bonds no less powerful than they are incomprehensible, the care for the conservation of this body incites the soul to refer everything to itself, and gives it an interest which

is contrary to the general order, which it can nevertheless see and love. Then it is that the good practice of his free-will becomes both merit and recompense, and that man prepares for himself an unalterable happiness in fighting against his terrestrial passions and keeping true to its first volition."[35] In a more solemn tone than James in his last lecture, this expresses very much the same thing: Man has a beautiful chance to be great, to conquer evil; he certainly would not forfeit the honor, the occasion of being a hero, of outdoing divine beings who simply cannot help being good. All this is simply taking man by his vanity so that he may not see the pettiness of his God; the ultimate purpose of the order of things not only is never made clear, but it is positively a stumbling block in a system which claims the rational God of Protestantism.[36]

3. The last rather striking similarity in the details of the two pragmatisms of Rousseau and James, which will be mentioned here is this: Both want men to be persuaded that there is a spiritual power above us, and they warn against the false claims of vain science. As indeed all superior beings in all times, they both have a deep sense for the mysteries that surround life, and will surround it even if we know a thousand times as much as we do now. In other words, both have a decided predisposition to mysticism. From James we have words like these appearing in *Will to Believe*: "The negative, the alogical is never wholly banished. Something—call it chance, freedom, spontaneity, the devil, what you will—is still wrong and other and outside and unincluded, from your point of view, even though you be the greatest philosopher" (p. viii). James has become a member of the Society for Psychical Research. In Rousseau one will not find the

[35] *Œuvres*, II, p. 264.

[36] Which at bottom is also James's. I have shown in my book how the God of Catholicism is more satisfying than the Protestant one. See *Anti-pragmatisme*, pp. 185-190.

theory expressed so plainly, because, as has been said above, he is not as philosophical a mind as James, not feeling the shortcomings of his system and thinking he can keep philosophical unity together with pragmatism. In a way, of course, his religion of "sentiment" is after all mysticism. But further we have a few very interesting facts showing that Rousseau was inclined to believe in certain kinds of *seconde vue* and in the realization of dreams. He experienced one illustration of *seconde vue* himself and told Bernardin de Saint Pierre about it. The latter relates the conversation as follows: "He firmly believed that Divinity had laws of action unknown to men. We were speaking of presentiment, striking dreams, and I quoted some to him. Then he told me: Once when I was in the age of innocence and purity, I was alone in the country, and I allowed my thought to wander freely until I finally completely lost consciousness of the landscape around me; and I saw a castle, avenues, hedges, a society of people whom I had never seen, but all so clearly, so distinctly alive that, filled with astonishment, I regained consciousness so struck with the picture that it remained profoundly impressed in my memory with all its details. Many years after I found myself in a castle with the same hedges, personages, figures, actions; and the whole so absolutely alike that I uttered a cry of surprise." (Pp. 102-103.) Now, if we open the *Nouvelle Héloïse* once more, which was to the end the favorite book of Rousseau, we find that he believed in dreams. In Part V, letter 9, St. Preux (Rousseau) sees Julie who comes herself to announce that she is going to die soon. Claire, hearing the dream (letter 10) is all upset; and a few pages further we hear of the accident that caused the young woman's death. Furthermore we have a passage where St. Preux, in spite of the theories which were expressed at the very same epoch in *Emile,* actually believes in the interference of God in the affairs of this

world to grant a prayer. In Book V, letter 6, Wolmar tells his wife that her prayers for his conversion would have been heard long ago if there had been a God, and in a sort of ecstasy Julie answers: "They will be heard....I know not the time and the occasion. Might I obtain this in paying for it with my life! My last day would then be the most useful." And here again the presentiment on the one hand is realized, and the prayer is granted.

* * *

How shall we account for two philosophers so much alike in their departure from objective truth and separated from each other by a century and a half?

The explanation is not far to seek. They both were men before being philosophers; they both cared for the welfare of humanity to such an extent that they could not remain impartial in their attitude towards plain truth as the latter seemed to point to another direction than the one they wanted, and which would always be in full agreement with human ethics. And each lived at a time when society was threatened by scientific theories which were dangerous for the equilibrium of sound moral life int he community: the 18th century was facing materialism; our epoch is facing agnosticism. Rousseau and James both felt that scientific truth was not good for all, that it could easily be misinterpreted byt he unprepared minds of the masses, and they proposed pragmatism, i. e., to subordinate philosophy to ethics, to identify truthfulness and usefulness. That the intention was generous, no thoughtful person can deny. Whether the method is commendable is another question; but it is not my intention to discuss this here. I would rather end by asking another question.

Are Rousseau and James themselves satisfied with their theories?

As far as James is concerned I have tried to answer in my book in the chapter called: "Is James a Pragmatist?"

Moreover I have discussed above his *pluralism* and *meliorism*; nobody wilfully admits that his philosophy lacks a principle of unity; James needed it in order to remain a pragmatist.

What about Rousseau? I doubt whether he was ever entirely convinced by his own philosophy.

As early as the time when he wrote his first "Discours" he realized the difficulty of his position (see the last pages of it): if science and art are really bad for civilization, bad morally for nations, then one ought to do away with them. Rousseau obstinately refuses to draw this conclusion; and after several attempts, to reconcile things, he gives this as his final theory: "When people are corrupted [as we are] it is better that they should be educated then not (*savant qu'ignorants*); when they are good it is to be feared that science will corrupt them" (Letter of July 15, 1768). Now this cannot be understood otherwise than: Prevent people from getting corrupt by allowing them to get objective truth, science and art; but once they *are* corrupt, it is better that they should corrupt themselves more....Of course Rousseau could not mean that.

Further, I should like to call attention to Rousseau's inconsistency, when he maintains that botany, which is a science also, ought not to be studied for merely practical purposes. At the end of his life especially he strongly objects to those who feel like asking the pragmatic question: *A quoi cela est-il bon?*, who study plants "only with the purpose of getting drugs and remedies." This "disgusting prejudice" is especially strong in France, he thinks: a *bel esprit* of Paris, seeing in London a public garden full of trees and rare plants, was "barbarous" enough to cry out "in matter of praise these words: 'Here is a beautiful garden for an apothecary!'" As to himself "all this pharmacy did not sully his enjoyment of the country."[37]

[37] *Œuvres*, IX, pp. 375-6.

Finally I refer the reader to the third *Réverie,* where in later years Rousseau discusses his own philosophy. Among other things he says: "I confess that I did not solve to my satisfaction all the difficulties which embarraassed me, and which philosophers constantly opposed to us. But determined to reach at least some decision in matters on which human intelligence has so little hold, and finding everywhere impenetrable mysteries and unsolvable objections, I adopted in every question the 'sentiment' which apepared to me best established by direct data. . . ." and so forth.[38]

One sees that there might be room for a chapter "Was Rousseau a Pragmatist?" corresponding to the one on James discussing the same question.

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[38] *Œuvres,* IX, pp. 342-343.

FERTILIZATION AND HYBRIDIZATION.[1]

[English Translation by Prof. C. Stuart Gager, University of Missouri.]

"Vom Vater hab' ich die Statur,
Des Lebens ernstes Führen,
Vom Mütterchen die Frohnatur
Und Lust zu fabuliren."[2]

IN these lines lies the whole problem of heredity and fertilization. What everybody can see, Goethe has voiced clearly and concisely in beautiful, simple words. We have one part from the father, the other from the mother. Or, as it is now usually put, the hereditary characters of the two parents are combined in the offspring.

It became the problem of scientific investigation to seek out the cause of this phenomenon. It could not be limited to man. The law mentioned by Goethe must be general, it must be true of the entire plant and animal world, wherever two beings unite for the production of progeny. Furthermore it cannot concern ordinary fertilizations only, but also those abnormal cases in which unlike individuals, belonging to different varieties or species, fertilize each

[1] The paper, read in Haarlem in the Dutch language, appears here in an enlarged form. My conception of the life-processes in the nuclei is chiefly based on the renowned investigations of van Beneden and of Boveri, as well as the most recent researches by Conklin (*Contr. Zool. Lab. Pennsylvania*, XII, 1902), Sutton (*Biol. Bull.* IV, Dec., 1902), Eisen, (*Journ. Morphol.* XVII, 1), Errera (*Revue Scientif.*, Feb., 1903), and of many others. For the literature I refer to E. B. Wilson, *The Cell in Development and Inheritance*, and V. Häcker, *Praxis und Theorie der Zellen- und Befruchtungslehre.*

My presentation of the processes of fertilization and hybridization is an outcome of the experiments which I have described in the second volume of my *Mutationstheorie* (Leipsic, Veit & Co., 1901-1903. English translation in preparation by Open Court Publishing Co.) H. DE V.

[2] Goethe, "Sprüche in Reimen," *Gesammelte Werke*, III, 83, 1871.

other. The products of such crosses we call hybrids, and for science they possess the great importance that, in them, the manner in which the characteristics of the parents are combined, can be studied more easily and clearly than in the children of a normal union. For, the more the parents differ from each other, with the greater certainty must it be possible to determine the share of each in the characteristics of the offspring.

Everywhere this law is confirmed, that the child inherits one part of its nature from the father, the other from the mother. The child is, therefore, on the whole, a double being, with twofold qualities, more or less distinctly separated, that may still be traced back to their origin. This *principle of duality,* as we might call it, dominates the entire theory of heredity; it forms the thread that binds together apparently separated cases; it serves as a guidance for the whole investigation.

This investigation occupies two different fields. On the one hand we have experimental research, on the other hand microscopical. Physiology ascertains the relations of the offspring to their parents; it analyzes their characteristics into their individual units, and tries to demonstrate their origin. The history of development discloses to us the corresponding microscopic processes; it looks for the smallest visible bearers of heredity in the cell, and investigates how they are maintained during life, and how, during fertilization, they pass on from father and mother to the offspring.

Few investigators master both provinces; their extent is much too great for that. And especially has the study of hybrids so greatly advanced in recent years, that even here a division of labor will soon be necessary. Both lines of work have therefore developed more or less independently of each other. In both, the main features of the problem begin gradually to arise out of the abundance of

individual phenomena. And thereby there is disclosed, one might almost say, beyond all expectation, an agreement in the results of both lines of investigation, which is so great, that almost everywhere the physiological processes are reflected in the microscopically visible changes.

It is true that the final analysis lies yet beyond the limits of our present microscopical vision. Compared with the enormous complexity of the hereditary characters of the organisms the anatomical structure of the cells and their nuclei, as it is known to us, is much too simple. The individual traits of father and mother can not yet be found in the cells of the offspring, but the investigations of most recent times indicate clearly that here also the limits of knowledge are being constantly extended.

The double nature of all beings that have sprung into existence through fertilization, is seen in their external appearance, as well as in the finest structure of their nuclei. The principle of duality obtains everywhere, even if, in individual cases, the demonstration of it is yet in its beginnings. But as far as the visible marks can be analyzed and the individual component parts of the nuclei can be traced, so far can the validity of the principle be proven even at present.

Let us consider first the external part, then the internal.

Goethe derived his stature from his father, and not from his mother, and it was not a stature between the two. The sum total of his qualities he had partly from his father, partly from his mother. The illustration explains the rule in a clear manner. In the offspring the characters of the parents are combined. Not always does the child get an even half from each; on the contrary, as everybody knows, it resembles the mother more in some respects, and the father more in others.

It is exactly the same with hybrids. With them a single character is generally derived either from the father or

from the mother. The hybrids of white and blue flowers usually bloom blue, those of a hairy or a thorny parent crossed by one without hairs or thorns are usually hairy or thorny. The crossing of a common evening-primrose with a large-flowered species results in a flower of the size of the former. But, if there are two or more points of difference they may be transmitted to the children partly by the one parent and partly by the other, and it is thereby possible in practice to combine the good characters of two varieties into a single race. Thus has Rimpau created a series of hybrid-races of wheat, and Lemoine has produced his large-blooming sword-lilies, able to withstand the winter, and thus have originated, in agriculture and horticulture, the countless hybrids, in which the favorable characteristics of various varieties are combined with more or less diversity. Combined, or as we usually say, mixed; though this is an expression which makes us only too easily lose sight of the independence of the individual factors in the mixture.

This independence is frequently difficult to demonstrate in the mixtures, that is, in the characteristics of the hybrids. Our means of differentiation only too frequently prove insufficient. In the clear cases, however, it appears very distinctly, and the greater the number of hybrids that are studied accurately and thoroughly, the more generally is the validity of the principle established.

If, for example, we find combined in a wheat-hybrid, the loose ear of the mother-plant, with the lack of awns in the father, the share of each appears simple and clear. In the mixture of the characteristics these two are so far apart, that they are always easily recognized. How are such characters united in the hybrid? Are they fused into one whole, or do they simply lie loosely side by side?

The splittings, which occur regularly in many hybrids, when propagated by seed, but also, in the case of a few, in

vegetative propagation, give us an answer to this question. Of the last kind the *Cytisus Adami* serves as the most beautiful and striking instance. It is a hybrid between *C. Laburnum* and *C. purpureus,* unfortunately its great significance for the main features of the whole problem has been underrated for a long time owing to the fable of its having originated as a graft. As a matter of fact no hybrids are obtained by grafting, no matter how great the mutual influence of the wild stock and the crown graft. As far as historical evidence goes, the *Cytisus Adami* has always been propagated by grafts since its first appearance, but it did not originally spring into existence in this way.

This tree teaches us how the qualities of the two parents are combined. Ordinarily they occur mixed, the leaves as well as the flowers having some features of the *Laburnum* and others of the *purpureus.* The totality of the characters lies, therefore midway between the two parents. But splittings do occur, and not at all rarely, or rather so commonly, that indeed every specimen of the hybrid, if not too small, will show them. In these splittings the types of father and mother separate sharply and completely. Some twigs will grow that are purely *Laburnum,* while others are only *purpureus.* The former are vigorous and long-lived, the latter remain weak and often die after a few years, which is the reason for their being seen less frequently. But even in this point they resemble exactly the respective parents.

Within the hybrid, the bearers of the parental characters are therefore arranged in such a manner that, so to speak, they can be completely separated, at any moment, by a simple cut. And, if not by a simple cut, then at least by a physiological splitting, which passes exactly between the two parental groups and does not leave in one of them any trace of the other.

In this manner we have to picture to ourselves, in a general way, the internal, invisible structure of the hybrids. The bearers of the characters of both parents are intimately connected, and together dominate the visible characteristics. But they are not, by any means, fused into a new indivisible entity. They form twins, but remain separable for life.

In all nature there is probably not another such beautiful instance of splitting as the above-mentioned *Cytisus*. But with lesser differences between the parents, splittings of the parental types occur frequently in the vegetative life of hybrids. Many horticultural plants, and especially the bulbous plants, furnish instances thereof; peas, corn, wood-sorrel, anagallis, oranges, and several others are known instances. The fruits that are half lemon and half orange, belong doubtless to this group. Among the hybrids of the common and the thornless thornapple (*Datura Stramonium*), individuals have been found, although very rarely, that showed a similar splitting, and which even bore on the same fruit, armed, as well as thornless cells. In my garden, I cultivated, for many years, a *Veronica longifolia* which was a hybrid from the blue species and the white variety, and correspondingly had blue flowers. But from time to time splittings occurred either one single spike bloomed white, or a few isolated white flowers appeared on an otherwise blue spike.

During the entire life, up to the time of the formation of the reproductive cells this internal dualism manifests itself in this way. Sometimes proofs of it are even found in the anatomical structure of the tissues, and of the individual cells, where the parental characters are set free and a mosaic-like structure results.

Macfarlane, who has made the most thorough study of the anatomical structure of hybrids, recognizes everywhere the principle of duality, and goes so far as to regard

every individual vegetative cell of a hybrid as a hermaphrodite formation. And the renowned French investigator of hybrids, Naudin, also expressed himself about forty years ago in a similar manner. *"L'hybride est une mosaique vivante,"* said he; we do not recognize the individual parts as long as they remain intimately blended, but occasionally they separate and then we are able to distinguish them.

We therefore regard it as established that, in the children, the inheritances from the fathers and mothers are indeed combined, but not fused into a new entity. Acting always conjointly under ordinary circumstances, they yet do not lose the power of separating occasionally.

But now arises the question as to what is anatomically visible of this union. Can the dualistic formation be observed within the cell? Do the parental inheritances, here too, lie side by side as twins?

The hereditary characters are contained in the nuclei, as was first declared by Haeckel, and later demonstrated by O. Hertwig, and, for plants, by Strasburger. This important law forms, for the present, the basis of the whole anatomical theory of heredity, and is recognized as such by all investigators. We may, therefore, expect to find in the nuclei, as well, the dualism of the parental qualities.

Every cell, as a rule, possesses a nucleus. This nucleus dominates the life-activity, and although the current functions can run their courses without it, no new ones can be introduced. In certain filamentous algæ (*Spirogyra*) Gerassimow succeeded in producing cells without nuclei; they retained life for several weeks, feeding vigorously, but nevertheless they always perished without any reproduction. In some tissue-cells the nucleus is constantly in motion, and according to Haberlandt's investigations, it stops longest where the work of the cell is most pronounced for

the time being, as for instance in unilateral growth, the formation of hair, local accumulation of chlorophyll etc.

This concentration of hereditary characters is most distinctly seen in the sexual cells. Here the other functions are reduced to a minimum. The nucleus dominates completely. In the male sperms the activity of the protoplasm is limited to moving around and to seeking the female cells. The body is made up almost entirely of the nucleus. In the higher plants the spermatozoids lack even the organs of free motion; they are carried to the egg-cell passively, in the pollen-tubes. The egg-cells are usually immovable and heavy in comparison with the male elements, since they contain the food substance necessary for the incipient growth of the germ, and for the first cell-divisions.

Now fertilization consists in the union of two cells, the male spermatozoid and the female egg-cell. This union is the means of combining the inheritance of the two parents, and therefore the nuclei play the main rôles. The nucleus of the egg-cell lies usually in its center; the male nucleus reaches it by passing straight through the surrounding plasm. Sometimes one sees quite distinctly that it no longer needs its own protoplasm since it strips it off and leaves it at the border of the egg-cell. In the *Cycadaceae*, in which the spermatozoa are just large enough to be discernible with the naked eye, the cytoplasm with all its cilia remains in the outer layers of the egg-cell, while only the nucleus penetrates more deeply. The beautiful investigations of Webber and Ikeno have brought this process to light.

Finally the two nuclei come into contact and unite into a single body. This is the most important moment of fertilization, the whole physiological process is concluded by this union.

Let us ask now what has been achieved by it. Appar-

ently very little, for the two parental nuclei are only closely appressed to each other. A penetration or fusion of their substance does not take place. They remain separate in spite of the union. With fertilization the life of the new germ begins, and in most cases immediately. Originally a single cell, the germ soon divides into two and then into more cells. But this beginning of the vegetative life takes place everywhere before the two parental nuclei have entered into closer union. Only after the first division does the limit become unrecognizable, the contact of the constituent parts of the male and female halves being now so intimate that there is at least the appearance of a fusion.

It was the Belgian investigator, van Beneden, who discovered this all-controlling fact. He first observed the independence of the paternal and the maternal nuclei in the intestinal worm, *Ascaris,* then elsewhere in the animal kingdom, and immediately recognized its significance. Since life could begin without fusion of the two nuclei, he considered that such a thing was not necessary, and assumed that all through life the two nuclei preserve their independence more or less completely.

According to this view the nuclei are double beings, and we thus find, in the material bearers of the hereditary characters, the duality of which Goethe sang in his "Sprüche in Reimen," and which the splittings of hybrids put so clearly before our eyes. Van Beneden chose the name *pronuclei* for the male and the female nuclei that are thus united, and speaks of a *pronucleus mâle* and a *pronucleus femelle*. This designation has been retained since that time, and recommends itself especially for the reason that the union of the two nuclei is usually simply called the nucleus of the cell; and this latter designation will probably not be changed, although the double nature of the nucleus is recognized. Therefore the pronuclei are

the entities that concern us; the nuclei are really double nuclei.

If the border line between the two pronuclei remained as distinct through life as before the first cleavage and at the time of it, van Beneden's view would hardly meet with any difficulty. But this is not so. Gradually the line of demarcation becomes blurred, and in most cases nothing more is to be seen of it in later life. But the richness of forms in nature is fortunately so great that the general phenomena in different organisms appear to us with an extremely varied distinctness. And thus it is also here. In one species the border line of the pronuclei is lost sooner, in others later. It is only a case of finding the best illustrations, that is, of selecting a species in which the paternal and the maternal inheritances remain longest visibly separate.

The discovery of such instances is the great merit of Rückert and Häcker. In the one-eyed water-flea of our fresh waters, the well-known *Cyclops vulgaris*, and its nearest allies, they found a group of animals in which the pronuclei remained distinctly separate for a long time. Sometimes during several consecutive cell-divisions, sometimes for a longer period, and, in the best cases, during almost the entire vegetative life, the double nature of the nuclei can here be directly seen. What van Beneden concluded from the incipient stages was here irrefutably proven.

The double nature of the nuclei was also demonstrated more or less distinctly, and during a shorter or longer series of cell-divisions, in other cases, by other investigators. It was observed in *Toxopneusthes* by Fol, in *Siredon* by Kölliker, in *Artemia* by Brauer, in *Myzostoma* by Wheeler, in the *Axolotl* by Bellonci. These and numerous other observations now place the law quite beyond a doubt. The independence or autonomy of the pronuclei corresponds

everywhere with the mode of union of the visible parental characters in the offspring.

In the snail-genus *Crepidula,* Conklin recently discovered a case in which the double nature of the nuclei can be demonstrated perhaps even more clearly and easily than in the Cyclops. If the two nuclei remain side by side all through life, the question arises as to how they dominate together the development of the child, the unfolding of its characteristics. Here, too, the results of physiology and of anatomy work beautifully together, and here too, Goethe's lines serve as a guide. Certain peculiarities are inherited from the father, others from the mother. One individual inherits them in this, another in that mixture. The inheritance therefore consists of separate qualities, which may be united in various combinations in the offspring. We are taught the very same thing by hybrids, especially in their progeny, and the rich floral splendor of our horticultural plants shows us what an endless number of combination-types has already been achieved with comparatively few characteristics.

But we shall not yet leave the subject of the nuclei. The independence of all the hidden potentialities, which in the physiological field is most sharply defined in the theory of pangenesis, we can of course not hope to see reflected in the nuclei. We must, at least for the present, be satisfied to find here any independent parts in the nuclei.

It was well known to the older investigators, and, among botanists, especially to Hofmeister, that the nuclei are not structureless formations, but that they exhibit more or less distinctly certain internal organs. But only about a quarter of a century ago by means of better methods of investigation did Flemming in the zoological field, and Strasburger in the botanical, succeed in getting a deeper insight into this structure, and soon afterwards Roux showed how these achievements are entirely in harmony

with the requirements of the theory of heredity. Since then, numerous investigations have confirmed and extended these results, and especially has Boveri brought out the main features in the wide range of phenomena. To him we owe the principle of the independence of the individual visible component parts of the nuclei, a principle, which, in spite of much opposition, is more and more strongly supported, and which has found in the most recent studies of Sutton a brilliant confirmation.

What Boveri's theory offers us is, in the main points, as follows: All the bearers of hereditary characters lie in the protoplasm of the nucleus, in the nuclear sap, as it is usually called, as definite particles, which can be brought out by various methods as distinctly recognizable parts, and which are combined into threads. It is true that one cannot see the individual bearers, because there are too many of them and they are too small. Even a counting of the smallest visible granules succeeds only rarely. In the nuclei of an American salamander, *Batrachoseps,* the members of the nuclear threads are most distinct; at least Gustav Eisen succeeded in making an approximate count of the smallest visible granules. In every pronucleus they form 12 chief parts, the so-called chromosomes. Every chromosome showed as a rule a subdivision into six sections or chromomeres, and every chromomere, in turn, appears again to be built up of six smallest granules, the chromioles. All in all there are here then about 400 distinguishable particles in the individual pronucleus. The number of hereditary characters must certainly be much higher than 400 for such an organism; it would more likely have to be estimated at ten times that value. We must therefore be satisfied, for the present, with the observation of groups of units in the nuclei.

In the end there will surely be found a way of seeing the individual units also. But the resolving power of our

microscope will finally reach its limit, and we shall probably never be able to see much smaller granulations than the smallest elements that are visible now. So far, even the causes of many contagious diseases, in plants as well as in animals, are still quite invisible. But the calculations which Errera has lately made on the limits of the smallness of organisms still allow us full play. In *Micrococcus* he finds a structure composed of about 30,000 protein molecules, but many nuclei are much larger. It can not yet be estimated of how many molecules a whole nuclear thread is composed, but it may be assumed with certainty that not every one of its granules has such a complicated structure that it could hold the factors for all peculiarities of the whole organism. Their smallness would rather lead us to suppose that every one of them could, at the most, represent only a small group of such units.

To prove this, on the one hand microscopically, on the other hand experimentally, is the task that Boveri set for himself.

The filamentous framework in most nuclei, recognizable by certain staining methods, is now admitted by all investigators as the idioplasm, the bearer of the hereditary qualities. This thread is very delicate, and seems to form a skein. But when the nucleus prepares to divide, the thread contracts, and thereby is seen, what had hitherto been invisible, that it is composed of several separate threads. In the nucleus there are several threads and not one single one. When the contraction of the thread is advanced so far that the individual parts have become quite short and thick, they are called chromosomes. In the nuclei of the body-cells these always occur in an even number, one-half belonging to the paternal, the other to the maternal pronucleus.

In a series of classical investigations Boveri succeeded in showing that the individual chromosomes, on elongating

again, when the division is accomplished, retain their independence. They remain the same during their whole life, elongating and shortening alternately throughout their entire development. The purpose of the shortening is to make possible an even division of all parts during cell-division; the threads then split lengthwise, in such a way that every single bearer of heredity first doubles, and then sends the two halves into the daughter-nuclei. This, of course, could hardly be accomplished in a skein. On the other hand elongation has for its object the freeing of the bearers of heredity from that crowded accumulation, their task being to control and to direct the life functions of the cell, and to that end they must be able to enter into as free a contact as possible with the granular plasm. An arrangement in rows, at least of those bearers that are to become active, is the necessary condition thereto, and it is evidently reached by means of the elongation of the threads and the formation of the skein.

In order to make possible an orderly retreat of the individual threads out of the tangle of the skein, every thread is firmly attached by one end to the nuclear wall. It retreats to this point, which is at the same time the point at which its two halves, during cell-division, are pulled apart after the splitting. The whole regularity of the process would be hard to explain without this firm implantation of the individual nuclear threads, as demonstrated by Boveri. Where the nuclei are sinuate and the nuclear threads are attached in the individual curves, the conditions are specially clear.

In a species of locust, *Brachystola magna*, Sutton found the same implantations of the nuclear threads on the curves of the nucleus. But here every thread, of which there are eleven in every pronucleus, forms a skein after the cell-division. These skeins of one and the same nucleus remain separated from each other for a long time, and the inde-

pendence of the chromosomes can hence be directly demonstrated, even at the stage of the skein. This locust has also proven very instructive in another point of Sutton's studies.

In general, one finds the individual chromosomes to be of unequal length in the most various nuclei. But, in the species of locust mentioned, this length occurs in such a characteristic manner that the chromosomes can be easily recognized in the successive cell-divisions. The pictures taken at the successive stages allow one to follow up, without difficulty, the identity of the short and thick nuclear threads. In doing so one sees that, in the double nuclei, the nuclear threads lie in pairs, that is, that there are two nuclear threads of each individual length. Evidently these belong together in such a manner, that in every pair one thread belongs to the paternal and one to the maternal pronucleus. A border line between them is nowhere to be seen, and yet their independence is very evident. And this harmonizes with the conception, as detailed above, that, according to the species examined, this limit can be observed for a longer or shorter time.

Microscopic examinations teach us, then, to recognize the independence of the two pronuclei, as well as the autonomy of the individual nuclear threads or chromosomes during the development of the entire body. The agreement of this observation with the phenomena of heredity may be considered as fully established.

But it is another question whether the individual chromosomes correspond also to special groups of hereditary characters, or, in other words, whether the bearers of the latter are strictly localized in the nuclear threads. This question can obviously be answered only physiologically. It amounts to a decision as to whether, if definite chromosomes, or definite parts in them, as for example, single chromomeres and chromioles, were wanting, definite ex-

ternal characters of the organism would also be lacking. If it were possible to kill a nuclear granule without otherwise injuring the germ, what would be the consequences?

Engelmann has taught us, in his revolutionizing investigation on the activity of the individual chlorophyll grains, how the focal point of a lens can be moved over the field of a microscopic preparation, thereby lighting up quite small portions of a cell, and how these portions can thereby also be heated, and in that way killed. If a part of a nuclear thread could be killed in this way, the externally visible consequences would certainly allow us to draw conclusions on the relations of this part to the hereditary characters. Perhaps an analysis of heredity can some day be made by this method, but the technique is not yet sufficiently advanced for this purpose.

However, there is another means of removing individual chromosomes, and this again we owe to the classical investigations of Boveri. He found it in abnormal processes of fertilization as they occur at times in eggs of sea-urchins and star-fish, and it can be quite easily produced artificially. It would lead too far from the main question to go into details here. The important point for our purpose is that, by certain interferences, a fertilization of one egg with two spermatozoa can be achieved. This process of dispermia leads in the nucleus of the germ, not to a double, but to a triple number of chromosomes. In the successive divisions the conditions become correspondingly intricate, and almost any imaginable abnormal number of chromosomes occurs. Nevertheless, the germs develop in some cases, and then show deviations from the normal type which allow a recognition of their normal relations to the structure of their nuclei. Without doubt the germs can, in every case, develop only those qualities the representatives of which happened to be preserved in their nuclei.

We shall leave the nuclear threads, at present, and

return to the two pronuclei. We saw them intimately combined during the entire development of the body. Now the question arises as to how long this union persists. And since the double nuclei of the body originated during fertilization, it is evident that the conjugating cells must have single nuclei, and therefore that the separation of the pronuclei must take place at the origination of these cells.

This fact is now so generally established, for animals as well as for plants, that it may be regarded as one of the strongest foundations of the whole theory of fertilization. Wherever it is possible to count the chromosomes, we find in the somatic cells twice as many as in the sexual cells. The former contain double nuclei, the latter single nuclei, or pronuclei.

The sexual cells in animals originate directly from the somatic cells, but in plants there is more or less preparation. Correspondingly, the two pronuclei separate in animals at the formation of the egg- and sperm-cells, but in the case of plants before that. In the seed-bearing plants it is the period of the origination of the mother-cells of the pollen and of the embryo-sacs. Therefore all cell-generations which appear after this moment, and up to the final production of the egg-cells in the embryo-sac, and of the sperm-cells in the pollen-grains and their tubes, possess only pronuclei. Such cells are called sexual, and the period of their formation the sexual generation. In ferns the entire life-period of the prothallium lies between the origination of the sexual cells and the appearance of the egg- and sperm-cells. This small plantlet, though built up of hundreds of cells possesses, therefore, as Strasburger has demonstrated, only pronuclei. The alternation of the sexual prothallia and the asexual fern-plant is called the alternation of generations; the two generations are hence distinguished from each other fundamentally by their nuclei, which in the leafy plants are always double nuclei, and in

the prothallia always pronuclei. This difference is so constant that one feels almost inclined to call the pronuclei prothallial nuclei.

At the moment when the two pronuclei separate, single nuclei appear in place of the double nuclei, and the double number of nuclear threads is thereby reduced to a single one. This process is usually called the numerical reduction of the chromosomes; but this imposing name means nothing but the separation of two nuclei which had so far worked together for a period. It is like the parting of two persons who have walked along together for a while, and will be looking for other companionship presently. And this they achieve by fertilization.

This parting has been minutely studied by numerous investigators. It has the appearance of a nuclear division of a very special nature, and is frequently called the reduction-division, or heterotypic nuclear division. It is necessarily accompanied by a cell-division, since the two separated pronuclei can only part in separate cells, but this cell-division does not always follow immediately, but only after a second essentially normal division of the nuclei. There result, in that case, four sister-cells instead of the usual two.

Shortly before their separation, the chromosomes lie together in pairs, always one in the paternal pronucleus united with the corresponding thread of the maternal pronucleus. They are placed lengthwise side by side. Hence the separation evidently occurs by a longitudinal line, and, in by far the greatest number of cases, this so-called longitudinal splitting of the chromosome-pairs has been observed in the origination of the pronuclei. It is true that this does not always succeed at a first glance, and it is right here that the differences of opinion between different investigators have blurred the picture for a long time. But gradually it was discovered that there are a number

of secondary details which may obscure the main features, and we owe it chiefly to Strasburger that the latter stand out clearly in the plant-kingdom. In the animal kingdom, however, there is still a series of cases which do not follow this rule, and where the chromosomes of the pronuclei are not placed lengthwise side by side at the moment of separation, but are connected at one end. Hence the separation here takes the form of a transverse division. Some insects and fresh-water crabs, some molluscs and worms offer the best known instances, but according to the most recent studies of de Sinéty, Cannon, and others, the assumption gains ground that here too the microscopic pictures, on closer observation, disclose a better fitting into the otherwise general scheme. It is also possible that, after the longitudinal splitting, the nuclear threads still remain connected for a while by their ends, before they finally separate.

The male and the female sexual cells usually originate in separate organs, frequently on special individuals. This goes to show that, at their origination from the body-cells, the paternal pronuclei do not become sperms and the maternal ones egg-cells. On the contrary, the two pronuclei of a mother-cell in the ovary can become egg-cells, and the two pronuclei of a pollen mother-cell can both give rise, by further splitting, to the formation of spermatozoids. Accordingly, one-half of the forming sperms gets paternal or now grand-paternal pronuclei, and the other half grand-maternal. The same is true of the egg-cells, and this holds good in spite of the circumstance that, in consequence of the crowded condition of the ovaries, the larger part of the female cells has regularly to be sacrificed every time.[3] Therefore fertilization may result in offspring with pronuclei from the grandfather or grandmother only, or from

[3] The reference is to the resorption of the sister-cells (when such occur) of the embryo-sac mother-cell. *Tr.*

both. This circumstance may not be without significance in considering the resemblance between grandparents and grandchildren among men.

But it is not by any means decisive; daily experience teaches that not only in a part of the progeny, but doubtless in all the offspring, there may be an admixture of the characters of the grand-parents also. This indicates that the separation of the pronuclei is not of as simple a nature as the microscopic pictures might lead one to believe. Another process, which, until now, has defied detection, must take place, probably in the smallest, but to us invisible granules of the nuclear threads. That this is the case we learn especially from the processes in hybrids and their propagation. Here, splittings and new combinations of the characteristics of the grand-parents occur in apparently incalculable numbers, and here it is distinctly seen that the pronuclei do not separate without a lasting reciprocal influence.

We shall first try to get a conception of this influence, for the facts concerning hybridization are rather involved; they can be most clearly explained by means of such a hypothetical conception. We shall accordingly assume a mutual influence as an established fact, and inquire how this can take place.

First of all it is clear that it must be finished before the separation of the pronuclei. Once they are apart all intimate relation between them ceases. They go their separate ways, each living for itself. Only in the double nuclei do the paternal and the maternal pronuclei lie so close together that their individual parts can exercise an influence on each other.

We have further seen that, during the life of a double nucleus, throughout the successive cell-divisions, from the origination of the germ to the complete formation of the offspring, the contact of the pronuclei becomes gradually

more intimate. Before the first cell division they are, as a rule, still visibly separated; soon afterwards the border-line begins to look more indistinct, and, shortly before the formation of the sexual cells, the double nature is disclosed with certainty only in the rarest cases by special structural relations. It is, therefore, clear that their opportunity for mutual influence gradually increases during somatic life. Perhaps it first occurs only at the end, possibly even, only at the moment immediately preceding their separation. A decision on this point has not yet been reached.* But the above-mentioned vegetative splittings of hybrids indicate that the process is deferred as long as possible. It also seems simpler to assume that it occurs only in those cells which actually lead to the formation of sexual cells, because in the leaves, bark, and other vegetative parts of the body, it would evidently be without significance.

We therefore imagine the mutual influence to be exercised towards the end, or even at the very last moment before the separation of the pronuclei. In the first case it could extend over a long time; in the latter it must take place suddenly. In the first case the individual parts of the nuclear threads could be mated one by one; in the latter this would have to take place everywhere simultaneously.

How this process comes about is self-evident when we assume special units, special granules in the nuclear threads, for the visible characters of the organisms. There must be as many units in the nucleus, as a plant or animal possesses individual characters. And this, of course, is the rule for both pronuclei. In the condition of the short and thick chromosomes these units lie crowded together. This is a definite stage in cell-division; the units, at least those

* More recent investigations indicate that the fusion of the male and female chromatin elements is completed during the stage known as "*synapsis*," which immediately precedes the reduction-division, or heterotypic nuclear division, referred to above. During synapsis the chromatin is aggregated into a compact mass within the nuclear cavity. *Tr.*

of the interior of the group, remain in a condition of enforced rest. But as soon as cell-division is completed, the nuclear threads stretch; they become quite long and thin, and indeed so long that a large part, perhaps most of them, possibly all of them, come to the surface. At least stretched out in a row in this way, the granules must then be arranged one after another, perhaps in the threads themselves, perhaps in their finest ramifications. Now they become active, and if, at this time, nuclear threads of the paternal and the maternal pronuclei lie together in pairs, every granule can enter into communion with its corresponding unit in the other pronucleus.

There is no reason to assume that the exceedingly fine structure of the nuclei, which is so strikingly to the purpose and yet so simple, should be limited to what is visible to us at present. On the contrary everything points to the probability that, in the internal structure also of the nuclear threads this same serviceable rule must prevail. The whole complicated process of nuclear division has for its object the division of the two pronuclei in such a way, that their daughter-nuclei will share alike in the hereditary characters that are present. The lengthening of the nuclear threads at the close of division, their so frequent ramification, and the seemingly irregular intertwining of their parts, evidently indicates the possibility of a domination of the cell-life by the bearers of the inheritable qualities.* These must impress their character on the surrounding protoplasm either dynamically or, as I have assumed in my *Intracellulare Pangenesis,* through a giving out of material particles to the surrounding protoplasm, and thus promote growth and development, in the prescribed direction, into the specific form of the species to which the organism belongs.

This secretion of material chromatin particles from the

* The "pangens."

nuclei was recently demonstrated by Conklin in *Crepidula*. In this way considerable quantities of chromatin, and therefore probably of pangens also, are transferred into the somatic protoplasm.

Thus we consider that the structure of the nuclear threads is such that it not only makes possible, but regulates and dominates the relations of the two pronuclei. In an ordinary animal, or in a plant which is not a hybrid, both pronuclei possess the same units, only with a somewhat unlike degree of development. We assume, therefore, that the cooperation comes about in such a way that the individual units in the stretched threads lie in the same numerical order. Then, when the threads are closely appressed lengthwise, in pairs, we can imagine all the like units of the two pronuclei to lie opposite each other. And this is obviously the simplest assumption for a mutual influence.

If every unit, that is, every inner character or every material bearer of an external peculiarity, forms an entity in each pronucleus, and if the two like units lie opposite each other in any given moment, we may assume a simple exchange of them. Not of all (for that would only make the paternal pronucleus into a maternal one), but of a larger, or even only a smaller part. How many and which, may then simply be left to chance. In this way all kinds of new combinations of paternal and maternal units may occur in the two pronuclei, and when these separate at the formation of the sexual cells, each of them will harbor in part paternal, in part maternal units. These combinations must be governed by the laws of probability, and from these, calculations may be derived, which may lead to the explanation of the relations of affinity between the children and their parents, the grandchildren and their grandparents. On the other hand a comparison of the results of this calculation and of direct observation will form the

best, and for the time being, the only possible means for a decision as to the correctness of our supposition.

The mutual influence of the two pronuclei shortly before their separation is therefore brought about, according to our view, by an exchange of units. Every unit can be exchanged only for a like one, which means for one which, in the other pronucleus, represents the same hereditary character. This rule appears to me to be unavoidable and really self-evident. For the children must inherit all specific characters from their parents, and they must also transmit all of them to their own progeny. This exchange must hence be accomplished in such a way that every pronucleus retains the entire series of units of all the specific characters, and this result can evidently be obtained only when the interchange is limited to like units.

We distinguish here specific characteristics from individual features. The units in the hereditary substance of the nuclear thread compose the former. Every species has an often exceedingly large and yet definite and invariable number of them. The sum total of these units forms that which distinguishes any given species from all others, even from its nearest allies. A complete diagnosis of a species would have to embrace all of these characteristics, and therewith all the material bearers underlying them.

The individual features, that is, the differences between the individuals within the species, and not only of the systematic but of the so-called elementary species, are of quite another nature. It is true that they are, in a way, hereditary, but with that they are subject to constant changes. The average stature of man remains the same in the course of centuries, for the same race (elementary species), but the individual stature changes constantly from one individual to another. In the somatic cells of man the bearers of the stature of the father lie opposite those of the mother. At the moment of exchange these are mutually transferred,

and the sexual cells receive partly one, partly the other stature, but this in the most various combinations with the other characters. Thus one might continue. Every visible quality, every trait of character is to be found in all individuals, only in some they are strongly developed and prominent, in others weak and recessive. Ordinary observation takes more interest in differences than in similarities, and for this reason the former are designated by contrasting expressions, as large and small, strong and weak, forward and modest. But these are, in each instance, only degrees of the same hereditary characteristic, or the same trait of character. And such more or less differing stages of development of the same inner units we represent to ourselves as the entities which are exchanged by the nuclear threads.

Individual differences are thus not included in the type of the species. They form deviations from this type, and are conditioned by causes which were formerly generally described as conditions of nutrition, but now more frequently as environment. Under these influences every character can develop more or less strongly than the average type. And the environment, provided it remains constant during the entire period of development, must affect all the unfolding characters in the same way. If it is favorable it furthers all parts of the body and all mental gifts, if it is unfavorable it has the opposite effect on all of them. Not, by any means, to the same degree upon all of them: that does not depend upon the environment but upon the units themselves; this, however, can not lead to essential differences between separate individuals. But our supposition of such a uniform environment would probably be met with only in the rarest of cases. And, as soon as it changed, it would influence one individual differently from the others. Moreover the characters do not unfold simultaneously, but successively, the higher one for the most

part later than the lower ones, mental characters later than those of the body, the reason later than the memory. And all those wheels work into each other so that small deviations will rather tend to become greater than to be equalized. Though children of the same parents but of different age might, during their entire youth, live under the same circumstances, they will yet react differently to them. This also holds true for plants where, in the same bed, a delay of only one day in germinating will, according to the weather, lead either to equal or to quite surprising differences in size and qualities.

If favorable and unfavorable conditions of life alternate during the individual development, and if they strike a group of individuals sprung from like seeds at different periods of their growth, quite a considerable degree of individual differences must thereby result.

These differences play in nature the same rôle as in human society. One is adapted for this kind of task, the other for that. With men it is the duty of every one to develop his own talents to the best of his ability, and to render as favorable as possible the circumstance for the most perfect development of his children. The highest efficiency of society in general demands of each the strongest effort in the direction of his most favorable talents. To ascertain this direction ought to be one of the chief aims of education and instruction. In animals and plants this highest efficiency can obviously not be achieved in the same way. And especially are the conditions different for plants, which are tied for life to the place where they germinated. Here, as is well known, nature is assisted by the astonishingly great number of seeds; she sows so many in every individual spot that only the best, that is, the individuals best adapted for the given locality, need retain life. But, by sacrificing countless seeds, she also accomplishes here that adaptation of the individual

specimens which is the condition for the complete unfolding of their abilities and advantages.

Very great weight is therefore given to individual differences in the life of the entire species. The greater they are, the greater the power of adaptation, the greater the chance of victory.

And in this I see the significance of sexual reproduction. It mixes the potentialities that have developed in the single individuals in the most complete manner imaginable; it achieves, at one stroke, all possible combinations. It cancels, as Johannsen expresses it, the previous correlations. Asexual propagation confers a certain degree of variability, and this may be quite sufficient in many cases, especially in the case of a low organization or of quite special adaptation, as in many parasitic and saprophytic organisms. Under such conditions the variability remains, in a certain sense limited, more or less one-sided, because every individual is the result of the varying, but, on the whole, one-sided environment in which his progenitors existed. Only an exchange of qualities can help to overcome this one-sidedness; only this can cause all the combinations to arise which are demanded by the varying environments. If we assume that the bearers of the individual characters are, as a rule, independent of each other during their exchange, and also that the latter is ruled by chance, two pairs of characteristics would directly result in four, three in eight, four in sixteen combinations. The sum total of the points of difference of two parents must therefore give rise to such an incredible number of possibilities that no struggle for existence, no annual rejection of hundreds and thousands of germs could demand a richer material.

Hence sexual reproduction brings individual variability to its highest point. It produces a material that corresponds to almost any environment. It is the principal

condition for the greatest efficiency of cooperation, be it by a selection as free as possible of the line of development for the single individuals, or by a sacrifice of all the individuals that do not quite meet all the requirements.

This service of sexual reproduction is evidently not limited to a single generation. It exercises its influence throughout successive generations, and it is probably indifferent whether the effect follows directly, or whether it manifests itself in the course of time. Even without that, the complete utilization of all given possibilities requires, as a rule, more individual beings than are born in a single generation. And with this, the otherwise strange fact is explained, that the exchange of the units does not immediately follow fertilization, but only takes place a short time before the succeeding period of fertilization. But obviously an exchange, ruled by laws of chance, could not benefit a given isolated individual or, more correctly speaking, it would most likely, just as frequently be harmful as useful. It can only be of use in connection with an increase in the number of individuals, for it is its task to bring about as great a variety as possible, and with that, the highest possible prospect for the required quantity of superior specimens. At the moment when the production of the sexual cells begins, in such enormous numbers, it also finds the best opportunity for fulfilling its task.

Thus, sexual reproduction has only a subordinate significance for the children, while for the grandchildren it is of the utmost importance, because only for them does the urn mix up all its lots.

The same laws that govern normal fertilization, are, of course, valid for hybrids also. There cannot be special biological laws for them, because they are only derived phenomena, deviations from the normal. Now the question is, to which results, departing from the rule, will the common laws lead in these special cases. And with this

it is clear that the phenomena must keep nearer to the normal the less the deviation is from the type.

This type is conditioned by the fact that the two organisms that fertilize each other belong to the same small or elementary species. They have then, on the whole, the same characters, even if these are, according to their environment in various degrees of development. There are no differences among them independent of this, at least if we consider the cumulative effect of uniform influences in the course of several generations.

As soon as such independent differences occur, and as soon therefore as there are present constant contrasts, which are retained in the sequence of generations and cannot be blended by environment, we call the sexual union of two individuals a crossing or a hybridization. If the contrasts are slight, we call the two races varieties, if they are greater, they assume the rank of species. The crossing of varieties keeps quite near to normal fertilization; that of the species deviates the more the slighter the relationship between them. The crossing of varieties forms a type complete in itself, that of the species forms a series which descends from almost normal processes, by gradual progress, to a complete reciprocal sterility. The variety-hybrids are fertile like their parents, but in the species-hybrids the diminished fertility indicates abnormal phenomena either in fertilization or in the exchange of the units.

We must therefore discuss these two groups separately, and we shall begin with the varieties.

In daily life and in horticulture, any thing that deviates from the normal is called a variety. Even the new forms obtained by crossing are quite commonly counted among the varieties. In science, therefore, the word would really be useless. Nevertheless it has been retained and its meaning has been gradually limited. Especially in describing

horticultural plants the conception is sufficiently restricted by excluding on the one hand the hybrids, on the other hand the improved races obtained by selection, and finally the so-called elementary species that, taken together, form our ordinary species.

Upen reviewing the cases that are left, two types can be plainly distinguished, the constant and the inconstant varieties. The former are not inferior to true species in point of constancy. Their character varies, in the single individuals, around a mean, but in the main not more so than the corresponding characteristic of the species. From this they are separated by a decided chasm. In pure fertilization they never bridge this chasm, or at least, extremely rarely, but in crossing they revert very easily to the species. It is this very reversion that stamps them varieties, and when the crossing is not artificial but natural, brought about by insects, it escapes observation, and only the fact of the reversion strikes the gardener.

These constant varieties are, as a rule, distinguished from the species to which they belong, by lacking some striking quality that adorns the latter. Most frequently it is the coloring of the flower or, in the case of flowers with combined colors, as in the yellow and red tulips, one of the individual colors, that is wanting. Often they lack hairs or thorns, very frequently the development of the blade is arrested, and split leaves originate. In all of these cases there is no ground for the opinion that the failure of the visible character means also the loss of the respective unit. Rather does everything point to the fact that the unit has simply become inactive, that it is in a state of rest, or as it is usually expressed, that it has become latent. Especially the reversions, which in individual specimens of such varieties are, at times, quite common phenomena, betray this latent presence.

Inconstant varieties are distinguished by a strikingly

high variability, by an exceedingly great range of departure from the norm. But here we encounter the double meaning of the designation inconstancy. On the one hand the word means a certain relatively great richness of individual forms, on the other hand it relates to differences between the parents and the progeny. In choosing from an inconstant variety a single individual, and sowing its seed, after pure fertilization, the whole play of forms of the variety can be found again in the children,—hence a palpable proof of the inconstancy. But, on choosing several individuals, and on sowing their seeds separately, each of them will produce almost the same series of forms. The whole group is transmitted from year to year, and does not change. The variety has a definite circle of forms in which the descendants of every specimen choose freely their place, but they do not go outside the circle. The limits are constant, and remain so in the course of generations; within the limits, however, a motley variety prevails.

Such is the concept of plants with variegated leaves, of double and striped flowers, and many other most highly variable garden-plants. The new character is not based here on the loss or the latency of some characteristic of the species. Indeed, on the contrary, it is usually a peculiarity which is already present in the species itself, or at least in one of its races, in a latent state. Especially do variegated leaves occur, not so very infrequently, on otherwise green plants, and the same is true of stamens with petal-like broadenings. The relation of the inconstant varieties to the species from which they are derived, is therefore quite different from that of the constant varieties.

Nevertheless, the two crossings behave in the same manner in regard to their mother-species. From the latter they are distinguished, for the most part, only in one point, though sometimes in several. But we have always to deal

with the distinction between active as contrasted with latent, be it that the given character is active in the variety and latent in the mother-species, or latent in the former and active in the species itself.

If to this we apply the conception of the arrangement of the units in rows on the nuclear threads, as explained above, it is quite evident that everything will follow exactly the same course as in normal fertilization. Every unit in the paternal pronucleus corresponds to the representative of the same peculiarity in the maternal one. The nuclear threads fit as nicely into each other as in a pure species, and all the units which do not directly bring about the point of difference behave quite normally. Cooperation in vegetative life, and exchange during the formation of the sexual cells need not be disturbed. We may confine our whole consideration to the point of difference, and we shall select, for the purpose, as simple an illustration as possible, one in which there is only one difference between the species and the variety, for example, the color of the flower.

The material bearer of the color-characteristic is situated in the mother-species so that it can display its full activity while in the variety it is unable to do so. If the paternal and maternal nuclear threads of the hybrid come into contact for the purpose of exchange, and with the same sequence of units in both, the active unit of coloring matter naturally gets the equivalent inactive unit as an antagonist. With this it must therefore be exchanged. We assume that in this the latent condition is without significance, that hence the exchange comes about in the same manner as in normal fertilization.

Over this, however, the crossings of varieties have the great advantage that there the origin of the characteristic in question can always be clearly and positively recognized. Both units of a pair of antagonists are otherwise distinguished only by a more or less of development, here by a

sharp contrast. And for this reason it is experimentally much easier to discover the laws with varieties than with purely individual differences.

In doing this, two points have to be distinguished; the consequences of fertilization and the consequences of the exchange of the units. The former we see in the hybrid itself, the latter in its descendants.* And since fertilization and exchange are two such fundamentally different things, we must not wonder that there exist such decided differences between a hybrid and its descendants. These differences show themselves essentially by the fact that the hybrids of a mother-species with a variety of the same are alike, even if they are obtained in great numbers, while their descendants always display a certain variety.

Let us first consider the first generation of variety-hybrids. How do the two pronuclei, notwithstanding their inequality, cooperate in order to regulate the evolution? This question amounts to the same as asking, what is the sum of the influence of an active and a latent unit? At first glance one would expect that this influence would correspond to half the value of a pair composed of two active units. Previously this opinion was rather generally accepted, and there was an inclination to regard plants with intermediate characters as hybrids. Especially many plants with pale red or pale blue flowers were regarded as such. But the experience of later years has decided differently.

Variety-hybrids generally bear the characteristic of the species, sometimes fully developed, sometimes more or less weakened, but this for the most part only so little that

* In the fertilized egg, resulting from the crossing, the chromatin from the male and female parents is not completely fused. As pointed out in a preceding footnote (p. 534), this fusion, called synapsis, occurs as almost the last step preceding the nuclear and cell-divisions that give rise to the reproductive cells. The characters of the first hybrid generation are a result of fertilization. Following synapsis, the pure bred offspring of this generation differ from their parents and also among themselves. *Tr.*

superficial observation sees no difference. An active and a latent unit are not essentially different in their cooperation from two active ones; a fact which may probably be best explained by the assumption that two cannot accomplish more than one already does. This conception finds a very strong support in the results of the most recent investigations by Boveri on dispermia, which we have already partly discussed. By fertilizing one egg with two spermatozoa the composition of the structure of the nuclear threads can be altered in different ways, for instance, in such a manner that in one nucleus there lie not two, but three pieces of any one of its chromosomes. It might then be expected that the given characters would be very strongly developed, to about one and one-half of their intensity. But, as far as can be judged from Boveri's experiments, this is not the case, and the influence of the three equivalent units is not noticeably greater than that of two.

We come now to the progeny of hybrids, and we, of course, presuppose self-fertilization. At the formation of the sexual cells the two pronuclei separate; this happens at the origination of the egg-cells as well as of the sperms. Through exchange, the active unit of our differing pair combines partly with new units of the other pairs, and thereby new combinations originate as in ordinary fertilization. But if we consider only the differing pair, exactly one-half of the egg-cells must obviously have the paternal, and the other half the maternal character. Or, in other words, in one-half of the egg-cells the given character occurs in the active, in the other in the latent state. Exactly the same is true of the male sexual cells, the sperms, in animals as well as in plants, and independently from the circumstance that in the higher plants the sperm-cells are conducted to the egg-cells in the pollen-tube.

The male sexual products of a hybrid are therefore unlike each other, and the same holds true of the female. In the simplest case selected both groups consist of two types, in the more complicated cases this number will obviously become greater. The paternal and maternal factors of the hybrid become, in its progeny, grandpaternal and grandmaternal. Hence, in regard to the point of difference, one-half of its egg-cells and one-half of its sperm-cells have grandpaternal factors, while the other halves possess grandmaternal ones.

By means of this principle the composition of the progeny in the simple as well as in the complex cases, and for constant as well as for inconstant varieties can be calculated. Thus we obtain the formulæ which are now universally known as Mendel's law.

They indicate, for any given number of points of difference between two parents, how many children correspond to every individual combination of the respective character. And, on the whole, experience has so far proven the reliability of these formulæ for animals as well as for plants.

It would be too great a digression to consider here the formulæ themselves. We shall therefore leave the field of the variety-hybrids, and turn to the hybrids between different species, especially between allied elementary species.

In order to understand these we must get a clear idea of the nature of the points of difference in this case, or in other words, what is meant by relationship. Species originate from each other in a progressive way. The number of the units in lower organisms is evidently only small, and must gradually increase with progressing organization. Every newly arising species contains at least one more than the form from which it has arisen. Only in

this way can one imagine the progress of the entire plant and animal world.[4]

It is indeed questionable whether the acquisition of a single new unit, the increasing by one unit of the entire stock, amounting to hundreds and thousands, would be sufficient to make the impression of progress on us. The difference will in most cases be too slight. Only when two or three or more units have been added successively to those already present, will we recognize an increase in the degree of organization.

The progress of every individual species can apparently take different directions. In some genera there are species so typical that they may be regarded as the common origin of the others. Where these are lacking it is manifest that the systematic relations are still too incompletely known to us, or that the given forms have died out. Every species can therefore be compared with its own ancestors or with other descendants of the same ancestors.

This consideration leads us to the recognition of two different types of relationship, and therewith also of two groups of crossings between allied species, which have to be kept absolutely apart. One of them we shall call the avunculary, the other the collateral. In the first case we cross a form with an "avunculus" or ancestor in the direct line, in the latter case with one of its lateral relatives. Obviously the first relation is very simple while the latter is more complicated.

Every character and every unit corresponding to it,

[4] A quite different hypothesis is thinkable, as, for example, that suggested by G. H. Shull, "The Significance of Latent Characters," *Science*, N. S., XXV, 792, 1907.

"All the visible variations of the present plant and animal world were once involved in some generalized form or forms, and the process of differentiation pictures itself to us as a true process of evolution brought about by the change of individual character-determining units from a dominant to a recessive state. This conception results in an interesting paradox, namely, the production of a new character by the loss of an old unit."

This hypothesis, however, as de Vries has pointed out, seems too much like a revival of the old involution theory as opposed to epigenesis. (C. S. G.)

which in a crossing is present in one species and lacking in the older one, forms a special point of difference. Hence the simplest case is the one in which there is only one such difference between the two parents of a cross. But generally several of them exist.

Now in such a cross, the differing factors evidently do not find any antagonists in the sexual cells of the other parent. When, during fertilization, the pronuclei unite into a double nucleus, all the other units are present in pairs. Not so the differing ones; they lie unpaired in the hybrid.

If we apply this reasoning to our conception of the arrangement of the units in rows on the nuclear threads, the immediate result would be that their cooperation must be disturbed. The threads no longer fit, neither during fertilization and in vegetative life, nor later when the units are exchanged before the formation of the sexual cells.

If we imagine two corresponding chromosomes of the two pronuclei placed exactly side by side, and in such a way that every unit of the one has the corresponding unit of the other for a neighbor, this will occur in a species-cross only as far as the point of difference. Here one nuclear thread has one unit more than the other. The latter has, so to say, a gap.

The greater the number of points of difference, the more numerous are these gaps, and the more will the cooperation of the two nuclei be interfered with. And this must diminish the vitality of the germ or at least the normal development of all characters.

If the differences between the two parents are too numerous, a crossing, as is well known, remains quite without effect. Crossings between species belonging to different genera succeed in very rare cases only, indeed within by far the most genera even the ordinary systematic species are not fertile when united. Genera such as *Nicotiana,*

Dianthus, Salix, and others, which are rich in hybrids, are, as a rule the very ones in which the species are exceedingly closely related to each other.

Even if the agreement of two species is great enough for mutual fertilization, the life of the hybrid is by no means assured thereby. Some of them die as seeds within the unripe fruit, as has been specially described by Strasburger for the hybrid seeds of *Orchis Morio* after fertilization with O. *fusca.*

Others become young plantlets, but are too weak to develop any further, and perish during the first weeks after germination, as I have frequently seen, for example after crossings of *Oenothera Lamarckiana* and *O. muricata.* Or only the most vigorous individuals continue to grow while the weaker ones perish, and this, in dioecious plants sometimes results in the male seedlings perishing while some of the more vigorous female ones develop flowers, as Wichura observed in several willows. Finally there might originate hybrids that grow vigorously, but do not flower at all or only incompletely, or begin too late to do so. There is a whole series of cases between the unsuccessful crossings and the development of hybrids into adult plants. And on the whole this series runs parallel with the increasing systematic relationship.

If the hybrid has succeeded in reaching the period of flowering, that is, the period of the formation of the sexual cells, a new difficulty arises at the moment of the exchange of the units. Whereas, up to that time, the cooperation of the two pronuclei was more or less disturbed, now the gaps become very important. Hence the quite common phenomenon that the production of egg- and sperm-cells fails more or less completely, that the hybrids either produce no ovules that are capable of being fertilized, or no good pollen, or neither. They are more or less or even completely sterile. They either form no seed at all, or only

an insufficient quantity. Only where the differences between the parents are quite small, does one succeed in harvesting any seed, and even here, frequently only a little.

How the unpaired characters behave during the exchange, when they are not numerous enough to make a failure of the entire process, is at present unknown. Experience teaches, however, that in these cases the descendants of the hybrids do not display that multifariousness of type, nor those splittings that are characteristic of variety-hybrids. They usually all resemble each other and their parents, the original hybrids, and this constancy persists through the course of generations. Accordingly there originate races of hybrids which, apart from their possibly diminished fertility, can hardly be distinguished from true species. Sometimes they are found wild, as for example a hybrid race between two Alpine roses, and other races of the kind in the genera *Anemone, Salvia, Nymphaea,* etc. Sometimes they have been obtained artificially or have accidentally originated in the gardens. The genus *Oenothera* is exceptionally rich in such constant hybrid races, especially in the sub-genus of the common evening-primroses, *Onagra.* Very frequently such hybrids are simply described as species, on the one hand because they can be reproduced, without deviation, from seeds, and on the other hand because systematic works frequently do not sufficiently consider the elementary species. The distinguishing of the latter from hybrid races is frequently by no means easy.

The purpose of my explanations compels me to restrict myself to simple and clear cases. In nature these occur relatively rarely, and the individual elements of the phenomena are usually commingled in most motley variety. By far the greater number of crossings take place between parents, whose mutual relations do not wholly fit either the one or the other concept, but where the characteristics

of the different types of hybrids are intermingled. I cannot consider these cases here; they are of too complicated a nature for an address.

Only one point I wish to touch upon. In the preceding pages I have always taken for granted that the species and varieties are in their ordinary and unchanging state. But this is by no means always the case. The origination of new species and varieties demands that their immutability should not be absolute, or at least should be suspended from time to time. Experience confirms this by showing that there are periods in the life of species, during which they are, so to speak, especially inclined to produce new types. At that time they produce the new varieties and species, not only once but repeatedly, and not only a single one, but frequently a considerable number. Genera rich in species, such as the pansies and the rock-roses,[5] are the remains of such periods of variability, and everywhere in nature we meet with similar ones. In garden-plants we see, from time to time, periods during which certain varieties occur by preference, as the double dahlia of about the middle of the last century, the forms of tomatoes in recent decades, and numerous other instances teach us. On its first appearance the gardeners call the new form a conquest, the later appearances are only repetitions, and are therefore of only very secondary practical value.

The power of reproducing one or more new species indicates a condition of unstable equilibrium of the given internal units. In the nuclei the new characteristic is already invisibly present, but inactive. Certain causes, unknown to us, can transform this into a permanent condition. This state of unstable equilibrium may be maintained in the great majority of individuals, through a series of generations, as is the case with my *Oenotheras*. But from time to time, sometimes in individual cases, every

[5] *Sonnenröschen* (*Helianthemum*).

year, there is a shock, and the equilibrium becomes stable. The given individuals overstep their bounds, abandon the earlier type, and form a new species.

It is evident that in crossings such unstable units will behave differently from normal, stable ones. Their chance of becoming stable is evidently considerable, owing to the phenomena of fertilization and the exchange of units. In this way constant races originate, at least in the genus *Oenothera,* and this, on the one hand, with the respective characteristic in an unstable condition, or in other words, in a state of mutability; and on the other hand with stable equilibrium corresponding to a new species. But researches in this field are only in their beginning, and do not yet permit of a detailed analysis. Besides they represent, for the present, a case in themselves.

* * *

On reviewing, in conclusion, the course of our deductions, we see that hybrids follow normal fertilization quite closely, the more completely the less numerous and the less pronounced the points of difference between the parents of the crossing. If these are of such a kind that the number of units in one parent is different from that in the other, disturbances take place which, if of lesser influence, diminish the fertility of the hybrids, and if of greater significance, affect their own power of development, or even make the crossing a failure. If these units are present in equal numbers on both sides, and if the differences are limited to latency in one parent and activity in the other, the normal process is not at all disturbed, but striking phenomena occur, which find their explanation in the peculiar manner in which the parental inheritances cooperate in the hybrid and in the formation of its sexual cells.

This cooperation is reflected in the life of the nuclei. In fertilization the nuclei of father and mother simply

touch each other. In the course of development the contact becomes gradually closer, bringing their equivalent elements as near to each other as possible, in such a way that the latter finally all lie side by side in pairs. But the pronuclei by no means lose their independence thereby, and for the purpose of every nuclear division they separate their component parts more or less distinctly. Shortly before their separation, their leave-taking, they are still the same as before. But now they exchange their individual units, and thus cause the creation of those countless combinations of characters, of which nature is in need in order to make species as plastic as possible, and to empower them to adapt themselves in the highest degree to their ever changing environment.

This increase of variability and of the power of individual adaptation is the essential purpose of sexual reproduction. It can be attained only by a mutual combination in all conceivable forms of the peculiarities developed in different individuals in different directions and degrees. To this end the pronuclei mutually exchange their units from time to time, and by assuming, on the ground of experiments with hybrids, that this takes place, on the whole, according to the laws of chance, that is, according to the theory of probability, we have gained a basis which allows us to probe to its very bottom this most significant and mysterious process.

HUGO DE VRIES.

AMSTERDAM, HOLLAND.

THE NATURE OF VITAL PROCESSES ACCORDING TO RIGNANO.

[CONCLUDED.]

EXPLANATION OF ASSIMILATION.

(Rignano, p. 356): "The fact that strikes us first of all is, that the vital phenomenon depends upon continual reproduction, for assimilation constantly reproduces the substance which is gradually consumed. It is to be expected, therefore, that if there are any fundamental properties of living organic substance which explain the phenomena of development or of reproduction in general, they must then be capable of accounting for assimilation also inasmuch as it is itself also a phenomenon of reproduction.

"That being granted it will be worth while that we next stop for an instant to take a look at and consider briefly a few of the principal conceptions which biologists have put forward on the nature of either the vital phenomenon or of assimilation, and which are of the greatest interest from our point of view.

"Roux, for example, rightly urges that the nature of life must be dynamic. 'Life is in its essence a process, and cannot therefore have a static definition. It is therefore only a processive and consequently functional definition which can approximate the essence of organic life.'[1]

"On the other side we have already seen the reasons

[1] Roux, *Ueber die Bedeutung der Kerntheilungsfiguren.* Leipsic, Engelmann, 1883, p. 18. Gesamm. Abhandl., Bd. II, p. 142.

for concluding that the essence of the vital phenomenon consists in an activation of nervous energy. We recall that according to Orr for example, the fundamental property of living substance is an 'elemental nervousness.'[2]

"We have already seen also that Claude Bernard, in agreement with that, considers the sensibility of the nervous substance as nothing else than a particular modality of irritability, which would be a general property of all living substance. 'Sensibility,' writes he, 'considered as a property of the nervous system, is only a higher degree of a simpler property which exists everywhere in all living substance both animal and vegetable. It has nothing essential or specifically distinct. It is the special irritability of the nerve just as the property of contraction is the special irritability of the muscle and as the property of secretion is the special irritability of the glandular element. These phenomena are so many different degrees of one and the same elementary phenomenon.[3]

"Bard also remarks, that, if the nature of the energy constituting the basis of all vital phenomena must be single, the infinitely varied modalities which these same vital phenomena present must then be due to as many corresponding modalities of this single energy."[4]

Here must be considered the conception which Rignano has himself formed of the general nature of vital energy and which has already been stated in the introduction. He says (p. 361 ff.): "Vital energy, nervous energy, we must admit, will certainly be only a particular case of more general physico-chemical forms of energy already known, or yet to be known, and as such must necessarily be subject to the laws governing the latter, and also *a fortiori* to

[2] Orr, *A Theory of Development and Heredity.* New York, Macmillan, 1893, p. 86.

[3] Claude Bernard, *Leçons sur les phénomènes de la vie communs aux animaux et aux végétaux*, pp. 289-290.

[4] Bard, "La spécificité cellulaire et ses principales consequences," *La semaine médicale.* Paris, 10. Mars 1894, p. 116.

the laws governing all energy in general. But also as such, i. e., as a particular case of more general physico-chemical forms of energy, it will have in addition special laws of its own, which are only experimentally to be determined, and can not simply be deduced from the more general laws, even though it must always be subjected to them also. And these laws of its own are exactly what make of it, from a simply physico-chemical energy, vital energy. It is just this conception to which we have been led when we have attributed to nervous energy, taken as the fundamental basis of life, special properties, which electric energy, in certain respects related to it, does not on the contrary possess.

"If, passing on now to assimilation, we examine the conception which the biologists have made of it, we shall see that their opinions on that subject are quite remarkably concordant.

"Thus, for example, Lewes says: 'The peculiarity of vital processes consists in this; that living matter undergoes molecular changes of composition and decomposition which are simultaneous, and by this simultaneity it preserves its integrity of structure.'[5]

" 'Life,' remarks in his turn Oscar Hertwig, 'manifests itself, expressed in the most general terms, in this, that the cell, by virtue of its own organization and under the influence of the external world undergoes continual changes and develops forces whereby its organic substance, on the one hand continually destroyed with determined manifestations of energy, on the other hand is regenerated.' 'The life process depends then on a continual destruction and re-formation of organic substance.'[6]

"But the clearest and most suggestive of all is Claude

[5] Lewes, *The Physical Basis of Mind.* London, Kegan Paul, Trench, Trübner & Co., 1893, p. 5.

[6] Oscar Hertwig, *Die Zelle und die Gewebe,* Bd. I, p. 54, and Bd. II, pp. 190-191.

Bernard in the following celebrated passage, 'The characters of life considered in their essence and in their entirety can be classed in two great groups:

" '1. The phenomena of consumption, of vital destruction, which correspond to the functional phenomena of the organism.

" '2. Plastic phenomena or phenomena of vital creation, which correspond to functional repose and to organic regeneration.

" 'Everything which goes on in the living being is in relation to one or other of these types; and life is characterized by the union and combination of these two orders of phenomena.

" 'Disorganization or "dis-assimilation" uses up living material while the organs perform their functions. Assimilative synthesis regenerates the tissue. It reassembles the reserve materials which the functioning organism must use up. These two processes of destruction and renovation, although inverse, are absolutely connected and inseparable, in the sense at least that destruction is the necessary condition of renovation. The phenomena of functional destruction are themselves the precursors and instigators of material renewal of the formative process which completes itself silently in the interior of the tissues.'[7]

" 'But the underlying reason,' says Dastre, 'of this interdependence between chemical destruction and function is made recognizable by energetics. A part of the organic material (reserve material, but also living protoplasm) becomes decomposed, chemically simplified, reduced to a lower degree of complexity, and abandons in this descent the chemical energy which it enclosed within it in the potential state.

" 'Every act which gives out energy, which produces

[7] Claude Bernard, *Leçons sur les phénomènes de la vie communs aux animaux et aux végétaux*, pp. 125-127; 157; 347-348.

heat, or movement, every manifestation whatever which can be regarded as a transformation of energy, necessarily consumes energy, and this is borrowed from the substances of the organism. The functioning of muscle produces heat and movement, the functioning of glands produces heat, the functioning of nerve and brain produces a small quantity of electricity and heat. All these manifestations of energy rest upon a destruction of organic matter, a chemical simplification as source of the energy manifested. In this way material destruction not only coincides with functional activity but is the measure and the expression of it.

" 'The reconstruction of protoplasm is on the contrary a phenomenon of evident synthesis, of a certain chemical increase of complexity, since this living protoplasm stands in a way at the highest stage of complexity. Its formation at the expense of simpler nutritive materials requires then an appreciable quantity of energy.

" 'The phenomena of living beings,' continues Dastre, 'may be divided into two categories. Some are intermittent, alternative and are produced or accentuated at certain times but can not be continuous. These are *functional processes*. There are others in which this property of sudden and intermittent expenditure of energy does not appear at all. They are in general *nutritive processes*. The muscle which contracts, functions. It has an activity and a repose. During this apparent repose one could not say that it was dead. It has life and this is here obscure in comparison with the manifest activity of the functional movement.

" 'The phenomena of functional activity are those which catch the eye and by which we are inclined to characterize life. These are conditional upon processes of consumption, of chemical simplification, of organic destruction through which energy is set free. And it is quite necessary that it should be so since these functional manifesta-

tions expend energy. These phenomena in which vital activities are most apparent are the least specific. They have only the character of general phenomena.

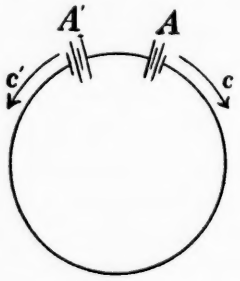
" 'The phenomena which accompany functional repose correspond to the reconstruction of the reserve materials destroyed in the preceding period, to organic synthesis. This remains in the words of Claude Bernard, "internal, silent, hidden in the expression of its nature, reassembling silently the materials to be expended. We never see these phenomena of organization directly. Only the histologist, the embryologist tracing the development of the element or of the living being notes the changes, the phases which discover to him this homely work, here a deposition of material, there the formation of a membrane or a nucleus, yonder a cleavage or a folding, or a renovation." This category of phenomena is the only one which has no direct analogues. It is peculiar to the living being and limited to it. This developmental synthesis is the true vital phenomenon. Life is a creation.'[8]

"This new formation of living matter which goes on during the so-called functional rest we must then seek to explain through the properties which we have postulated above for nervous energy taken as the basis of the vital phenomenon.

"For this purpose let us suppose in conformity with the hypothesis set forth above that one could construct an elementary electric accumulator capable of furnishing a single given intensity or specificity of current and that its electro-motive force or difference of potential between the poles is proportional to the mass of substance constituting its charge; as if each new increment however small of this mass constituted an element by itself which would be added in serial order to the others.

[8] Dastre, *La vie et la mort.* Paris: Flammarion, 1902, pp. 103, 107, 208-209, 210-211.

"Let us consider two of these accumulators, A and A', inserted with their poles inverted in the same circuit. Suppose they are quite identical, except that the one, A', is entirely without charge and the other, A, has its full charge. Let us suppose that the current, c, generated by A which tends to charge A' can under certain circumstances cause an oscillatory discharge, i. e., a continuous oscillation of the current, now in the direction of c, now in the contrary direction of c', and that certain external alternating currents could induce in the oscillating circuit sinusoidal electro-motive forces of the same frequence as this oscillating discharge and thereby strengthen the sinu-



soidal electro-motive force of the latter which at the beginning was determined by the original difference in charge of the two accumulators A and A'.

"Then with each half oscillation the one accumulator will become more strongly charged in proportion as the other discharges, and there will be produced as final result a series of oscillations with a consequent continual increase of the total mass of the two accumulators A and A', as long as the saline solution serving as their common aliment is not insufficient.

"If the amount of electro-motive force contributed by the induction current at each oscillation is proportional to the amount of electro-motive force which is directly de-

pendent upon the difference in charge between the two accumulators existing at any moment, if for example, it represents a definite fraction of the latter, and thereby will gradually decrease in amount as this difference between the two charges becomes less with each oscillation, then both the amount of this difference and that of the induced electro-motive force will sink to nothing after a certain period of time, theoretically infinitely long, practically more or less short, which we can call the period of reconstitution or of replacement of material consumed.

"As soon as the charges of the two accumulators have become equal there will exist no more provocation of oscillating currents and the total mass of the two accumulators whose increase had become always smaller and smaller will now not increase any further at all.

"But if at this instant either of the two accumulators suddenly becoming inserted aside from its own oscillating circuit at the same time *also* into one of the ordinary circuits, discharges into the latter wholly or partially, then the difference between the respective charges of the two accumulators will again be present and the former process of oscillation will begin again. And this will result again in the increase of the total mass of the two accumulators above the amount which it had already reached before this last discharge. We can compare this discharge of one of the two accumulators outside the circuit of oscillation, with the nervous discharge from the nucleus into its environment, that is, with the biological functional excitation which produces the same trophic effect.

"Further, if at the moment when the two accumulators have arrived at the condition of equality between their respective charges and so of repose, one of them, instead of becoming discharged into another circuit, becomes replaced by a third accumulator whose charge is different from the other two now equalized charges, the result will

be the same. And the impulse given to the process of oscillation will be greater, the greater the difference between the charge or electro-motive force of the new accumulator and of the old one replaced. In other words, to make use of biological expressions: the rejuvenescence of the specific potential elements formed by the pair of accumulators will be proportionally greater, the more quantitatively unequal are the two half elements which have become thus mutually fecundated.

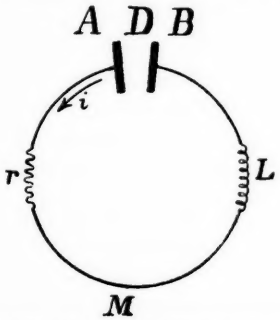
"If we substitute for the conception of electro-motive force that of nervo-motive force, our hypothesis concerning the nature of the vital process in each specific potential element or mnemonic element will consist simply in supposing that the latter is comparable to this pair of accumulators inserted with inverted poles in the same elemental oscillating circuit, which we would call intra-nuclear circuit, but in which there enters into play instead of the alternating electric induction current, general thermal energy in the same way.

"Assimilation, the new formation of living substance, would then be dependent, according to this hypothesis, upon a kind of rhythmic oscillatory charging and discharging flux, upon a kind of intra-nuclear oscillatory discharge which becomes induced by the extra-nuclear or functional nervous discharge in consequence of the disturbance of the equilibrium between the nervo-motive forces of the two accumulators opposite each other. The vital element would thus be conceived of as only a double specific elemental accumulator of nervous energy in continual charge and discharge.

"As will be noted we have here a phenomenon in some respects similar to the electric resonators of Hertz, in which an electric discharge caused by the difference of potential existing between the two armatures of a condenser, is transformed into an oscillating discharge. It

will be appropriate here to indicate briefly in just what this phenomenon consists.

"Let *A* and *B* be the armatures of a charged condenser which are suddenly connected with each other by an external conductor, *ArMLB*, in such a way that the latter makes a circuit open only at the point *D* of the di-electric. In the accompanying figure *r* represents the total resistance of the circuit and *L* the inductance or coefficient of self-induction of this circuit. When the capacity *c* of the condenser and the inductance *L* of the circuit are in a certain relation to each other, and *r* is *small*, we can get an oscillatory discharge which forms as it were a sinusoidal alter-



nating current: that is, the electricity oscillates from *A* toward *B* and from *B* toward *A*, with a frequency determined by the inductance *L* and the capacity *c*. If we cause the resistance *r* of the circuit to become constantly less by employing wires of constantly increasing thickness, we approach the boundary at which this oscillation will be able of itself to continue indefinitely.

"If in this case where *r* is very small, we excite in the circuit by induction sinusoidal alternating electro-motive forces of the same frequence as in the oscillatory discharge, then there will arise in *A* and *B* differences of very many volts even though the number of volts so induced be very small.

"Upon this principle depends, as is well known, the celebrated experiments of Hertz which in turn have formed the point of departure for wireless telegraphy.

"It is well known also that such an electric resonator has been rightly compared to a vibrating dynamic system, to a pendulum that has an oscillation time of its own, to a sounding chord which the smallest impulses having the same frequence as itself can set in vibration, even in strong vibration. What happens in it is a continual periodic transformation of energy. At the instant when the sinusoidal alternating current reaches its maximum intensity, one has the maximum of actual energy, while the condenser, on the other hand, possesses then no potential energy whatever. At the instant when the intensity of the current drops to nothing, the condenser shows the greatest deformation of the respective di-electric and possesses thus a potential energy fully equal to the actual energy possessed by the discharge at the moment of its greatest intensity, the process being thus exactly the same as in a pendulum in which potential energy is transformed continually into actual and *vice versa.*

"It will be sufficient here, for the purpose of a remote comparison, to note the fact just indicated, that an induced sinusoidal alternating electro-motive force in such an electric resonator, which need amount to only a very few volts, provided that it be of the same frequency as the oscillating discharge, will be able to induce in A and B differences of tension which may amount to many volts. For if we assume in the current so oscillating the faculty of depositing in each of the armatures of the condenser infinitely small particles of substance in series one after the other, until the total of their mass and the consequent electro-motive force surpass the electro-motive force in the opposite direction, which this current possesses at this point and at this moment, then it will not be diffi-

cult for us to understand the case in certain respects analogous, which we have assumed for the oscillating nervous discharges, in which the calorific oscillations which replace here the oscillations of the induction current continually increase the mass of living substance, which will in this way be 'assimilated.'

"Let us note that in the case of nervous currents we must assume that their specificity is constant even during the oscillation. At the same time, however, the duration of each nervous discharge, and hence of each oscillation also, in cases where the specificity i of the nervous current is something dynamically equivalent to the intensity of the electric current, must be definite and constant for every given specificity.

"For let us consider again an electric current. If its intensity i persists for a time t, the total actual energy furnished during the whole of this time by this current will be Eit, where E represents the electro-motive force. But this total energy will necessarily be proportional to the mass M of the substance whose decomposition during the time t has produced this current; one has thus $Eit = hm$, where h is a coefficient of proportionality, dependent solely upon the units of measure selected. But if the supposition which we have accepted for nervous currents in general holds good also for this electric current, namely, that the electro-motive force is proportional also to the mass of substance which tends by decomposition to produce the current, then also is $E = km$, where k again is a coefficient of proportionality dependent likewise solely upon the units of measure which are adopted. Consequently the above equation would take on the following form:

$$km.it = hm, \text{ that is,}$$
$$it = h/k = H,$$

where H again is another coefficient of proportionality and

dependent alone upon the units of measure already fixed above, that is, upon a selected, constant number. It follows from this, that *it* is constant. And if *i* in its turn is likewise constant for each specific current, *t* must also be constant; i. e., each definite specificity of current, *i* will correspond to a likewise determinate and constant period of discharge.

"If then, no matter what conditions the different discharges of a current of the specificity *i* may induce, all these discharges can have invariably only the same duration *t* and if this holds also for those which constitute the oscillating discharge, then the oscillation itself, which consists of a doubled discharge, of which each one has a direction contrary to that of the other as we stated above, will have necessarily a very definite and constant period of its own which corresponds each time to the particular specificity *i* of its respective current.

"It follows that of all the vibrations of the different calorific rays, only those which have the same oscillatory period as the element being reconstituted will be able to some extent to give to the oscillating discharge of the latter an impulse which will be added to that received through the difference in potential of the pair of accumulators, and thus to have identically the same effect as that which the sinusoidal electric alternating induction current has upon the electric accumulator with an equal period of vibration. And this becomes so much the more clear since Maxwell's theory, of which it is scarcely necessary to remind any one, and which was wholly confirmed by the Hertzian experiments, has demonstrated the essential identity of these electric induction oscillations across the di-electric formed by the air, with light and heat vibrations in general. The only difference consists in the period of vibration which in both the latter is much more rapid than in the former.

"Thermal energy then, whether that which comes from

the irradiation of the sun and from the outer world in general, or that which is developed from chemical processes of decomposition and oxidation taking place in the interior of the organism, would, in as far as it is composed of heat rays of the most different periods of oscillation, constitute the general external stimulus which actuates indifferently all vital processes whatever. Particular kinds of energy, which oscillatory periods varying within narrow limits and possibly even with a single vibratory period, such as the rays of each of the elemental colors of the solar spectrum would constitute on the other hand, special external stimuli which activate only the vital energies of this or that corresponding specificity.

EXPLANATION OF NUCLEAR SOMATIZATION.

"Therefore if we suppose a cell to exist whose nucleus contains at the same time various specific elements, each having a specific vibration period of its own, and if we assume that this cell is thenceforth always exposed to the same external stimulus with a constant vibration period, then among all the mnemonic elements, that one which is syntonic with this external stimulus will increase in mass since it absorbs always larger quantities of the nutritive fluid, and at the expense of all the other elements, so that in this way it may result that it supplant them all and remain the sole survivor. We may express this process by saying that the cell has undergone a complete nuclear somatization.

"Let us assume inversely that a cell whose nucleus contains one or several mnemonic elements is exposed at the same time as to the other stimuli, also to a new external stimulus, whose vibration period may differ from all those of the mnemonic elements already present. Then we can assume that this new vibration period may communicate its own frequency to one of the oscillating discharges al-

ready present and probably not to the whole nervous current constituting one of these discharges, but to only a part of it, i. e., it will make it syntonic with itself. The result will be the gradual deposition of a new specific substance or mnemonic element which, if this new external stimulus does not permanently displace all the others but co-exists or alternates with them, will merely add itself to the pre-existing. We may express this process by saying that the cell has experienced the influence of the new stimulus to which it has been exposed, or that it has experienced the 'imprint' of the new condition through which it has passed.

"It is the same thing if we say that instead of being exposed to a new external stimulus, having a rhythm different from all the preceding, the nucleus is constrained, in consequence of any given new functional adaptation on the part of itself or of its immediate environment, to divide some one of its specific currents into two or more components, or indeed, to receive some new specific current derived from the combination of other specific currents of the environment.

"In the circumstance that at each alteration of any period of oscillation or of any specificity of current through the action of a new stimulus, external or internal, there follows immediately the deposition of a new substance which adds itself to all the others already present and remaining unaltered, and which is capable of exciting only such currents as are syntonic or specifically identical with that by which it was itself deposited; in this circumstance the first and fundamental mnemonic process underlying all living substance would consist. From it would then spring directly all the other processes, from histologic differentiation and the inheritance of acquired characters up to mnemonic phenomena proper.

"Let us note that for each specific discharge, for the intra-nuclear oscillating as well as for the extra-nuclear

functional, there will correspond very definite substances of dissimilation, for the different specificities of the nervous currents can be due only to the decomposition of substances similarly different. And even if the diversity of these extremely complex and unstable substances consists only in the different number and different mode of grouping of the same atoms of the principal elements which constitute all organic substance, nevertheless the respective substances of dissimilation to which each of these complex substances will give rise, will necessarily be different from one another. These substances of dissimilation, definite and peculiar for each specific discharge, will in their turn afford, by their entire or partial oxidation, products of excretion and secretion quite definite and differing from one cell to another. These products, in their turn, thanks to their peculiar physico-chemical properties, will impress upon the protoplasm or cytoplasm a corresponding physico-chemical character. And as at the same time the deposition and the arrangement of these materials in the body of the cell is a consequence, in part of the physico-chemical properties inherent in them, in part of the paths, which the respective extra-nuclear nervous discharges or currents will have followed in the cytoplasm according to their specificity, so it is conceivable how the *ensemble* of the mnemonic elements constituting a given nucleus can determine its own protoplasm or cytoplasm both from the purely physico-chemical and from the properly morphological point of view.

"We arrive thus at a constant double correlation between the cytoplasm, the species of nuclear excitation and the substance of the nucleus. The nuclear substance, in fact will determine at once the rhythm of charge and discharge, and the specificity of the corresponding nervous current; and this specificity of current, thanks to the substances of dissimilation to which it will give rise, will de-

termine the respective cytoplasm. Conversely, the rhythm, once it is modified by the functional stimulus, will immediately induce the corresponding modification of the specificity of current; and the latter in its turn will at once determine the substance of synthetization or nuclear substance, as also the substances of dissimilation of which the cytoplasm is constituted.

"It is not excluded either that chemical substances which may act upon the cytoplasm and modify it chemically can facilitate the formation of such or such substances of dissimilation and thus facilitate the production of such or such new specificities of currents which in their turn will deposit or determine the respective nuclear substance. In other words, we do not exclude that besides the physical functional stimuli which preferably influence the vital rhythm directly, there may also exist chemical functional stimuli, which act directly, rather upon the nervous specificity. But thanks to the close correlation between the specificity and the rhythm of these currents, both come to the same result, namely that each contributes its respective mnemonic element to the nuclear substance."

(Pp. 319-320): "Let us note, parenthetically, that nuclear somatization conceded, we must regard each of the substances which make up the different specific potential elements of any nucleus as capable of gradually replacing the others by continual increase of its mass, when the respective specific current, on account of the incessant repetition always of only one and the same stimulus passes very frequently through the nucleus. A nucleus thus somatized,—that is to say, one composed wholly of a single specific substance and which would acquire in this way, on account of the considerable mass of this substance a potential energy capable of overcoming a considerable resistance to its discharge, will then be able to respond to stimulus always in that single way only which corresponds

to the single specific nervous current which it is able to activate and which constitutes its irritability, even if it be provoked to discharge by external influences or accidental stimuli which are quite different from those to which it is ordinarily exposed. 'A muscle cell,' says Oscar Hertwig, 'replies to every kind of stimulus by contraction, a gland cell by secretion; an optic nerve can perceive only light, no matter whether it be stimulated by light waves, by electricity or by pressure. Similarly plant cells also are endowed with their own specific energies: the reaction to stimulation receives everywhere its specific stamp from the particular structure of the irritable substance, or in other words, irritability is a fundamental property of living protoplasm, but under the action of the environment manifests itself in specific reactions according to the structure of that protoplasm.' "[9]

Resuming again (pp. 377 ff.): "Let us summarize what has been said. The specific potential elements which have presented themselves above as specific elementary accumulators, and as mnemonic elements, appear now as specific vital elements, that is, as the smallest possible particles of organic substance capable of life. At the same time the denominations *potential* element and *vital* element, which might at first have appeared incompatible with each other, if the adjective *potential* had indicated a vital nonactivity at that time, become entirely compatible in consequence of the hypothesis which we have just set forth. According to this hypothesis, the element would be potential in so far as each of the two coupled accumulators would be able to furnish at need its proper extra-nuclear functional nervous discharge; and it would at the same time he conceived as in a *vital* process by reason of the intra-nuclear oscillating discharge, which continues incessantly between the two accumulators. Vital energy could thus present itself

[9] Oscar Hertwig, *Die Zelle und die Gewebe*, I, p. 76.

in three distinct modes: (1) In the potential, properly so called, which expresses itself in the phenomena of effective suspension of life or lethargy in its widest sense; (2) In the oscillatory potential, or the intra-nuclear oscillating discharge, which constitutes the essence of the period of so-called 'functional repose,' 'organic reconstitution,' 'storage of materials afterwards to be consumed,' 'assimilative synthesis,' or 'vital creation'; (3) Finally in the actual proper, or the extra-nuclear non-oscillating discharge, which constitutes the period of 'excitation,' 'functional activity,' 'wear and tear,' 'consumption of material stored up in the rest period,' 'disassimilation,' or 'vital destruction.'

"In this way, the fact upon which Dastre rightly insists, that 'after the explosive destruction of a chemical reserve,' constituting the functional activity, the living substance still always preserves in the state of repose which succeeds the same properties though attenuated, which it manifested in the state of activity, would find an immediate explanation. Hence the period of repose cannot be of another nature than that of the state of activity as Claude Bernard was inclined to think. 'To-day,' writes Dastre, 'if we had to express a more personal opinion upon this important distinction of functional activity and functional repose, we should say that, after having distinguished the two categories of phenomena it is necessary to try to bring them together. It is necessary, for example, to seek what there is in common between the muscle in repose, and the muscle in contraction, and to perceive in the muscular tonus a sort of bridge thrown between the two conditions. The function would experience no interruption, but it would have its degrees. The muscular tonus would be the permanent condition of an activity which is merely susceptible of being considerably heightened or weakened.'[10]

[10] Dastre, *La vie et la mort*, p. 212.

"As conclusion of our exposition let us note very briefly that for three more of the most fundamental phenomena associated with vital activity this hypothesis upon the nature of life presents at least the beginning of an explanation. These are: rhythmicity, a characteristic property of all life phenomena; the phenomena of fecundation and rejuvenescence in general; and nuclear division with all its characteristic and remarkable details.

EXPLANATION OF RHYTHMICITY OR PERIODICITY.

"A whole series of facts forces us to the opinion, that rhythmicity should be reckoned among the most general characteristics of the modes of manifestation of vital energy. Beyond the fact that nearly all, and perhaps all external physical stimuli, from the thermal and luminous to the acoustic are characterized by vibrations; and beyond the other fact, a consequence of the first, of the physiological action exercised by musical rhythms and intervals for example, and by all the rhythmical manifestations of the most diverse energies, we see that a more or less manifest and more or less regular periodicity is a fundamental character of all or nearly all biological functions. One thinks at once for example of the synchronous rhythm of all the peristomal cilia of an infusorian—a rhythm which manifests itself in the two parts of an animal which has been divided, provided these parts remain connected by a bridge of protoplasm; of the rhythmicity present in the protozoa in general, present even within the cells in the pulsation of contractile vacuoles, which empty and refill themselves continually at regular intervals; of the beat of the heart, even independent of its connection with the nervous system; of the similar pulsations of the whole vascular system, the entire breathing apparatus, the uterus, and of many other organs; and finally of the periodicity of a whole series of physiological variations, which animals and plants

undergo as a result of corresponding periodical variations of the outer world, but which persist unaltered for some time even when the outer world or the periodicity of its variations may have changed.

"Now it is not difficult to conceive of this rhythmicity or periodicity which nearly all biological functions present, as a consequence more or less direct or indirect of the vital phenomenon in all its generality, when this phenomenon, be it only in so far as a phenomenon of assimilation, is itself essentially a rhythmic phenomenon.

EXPLANATION OF FECUNDATION.

"In regard to fecundation we know that it was Spencer who first recognized what has been more or less explicitly accepted by others, that it consisted probably in a purturbation of an equilibrium which tended toward a stability unfavorable to vital activity.[11]

"Now we have already seen how our hypothesis set forth above is able to make at once conceivable in what this equilibrium unfavorable to vital activity may consist. According to this hypothesis, it would consist in the equalization toward which the masses, and the corresponding potentials, of the coupled accumulators of each mnemonic element would tend and which they would eventually attain, and this equilibrium would be disturbed by the substitution for one of these accumulators of another specifically equal to it but differing in mass and potential. And it is precisely in this function of fecundation, of replacing in each couple one of the specific accumulators by another differing quantitatively as widely as possible that we find an explanation of the fact that the rejuvenation of the germ and the consequent vitality of the progeny to which fecundation tends, are proportionally greater when fecundation occurs not between individuals too closely alike, but

[11] Spencer, *Principles of Biology*, I. pp. 340-341; II, pp. 614-616.

rather between individuals who belong indeed to the same species but are somewhat dissimilar.

"According to the same hypothesis, this equilibrium could also be deranged by the extra-nuclear discharge of one of the two coupled accumulators, and this is just what is demonstrated by the universally known experiments upon the rejuvenescence of the infusoria, by which it appears that this rejuvenescence can be reacquired even without any need of the ordinary fecundating conjugation, simply by causing some change in the surrounding conditions of life, and thereby provoking a strong renewal of the functional activity.[12]

"Let us note parenthetically that if oscillating discharges take place between the corresponding separated specific accumulators or half mnemonic elements of the egg and spermatozoon respectively even when the egg and spermatozoon are still relatively distant from each other, i. e., before they could coalesce into a single fecundated nucleus, we can then understand how the space between each pair of these elements can and must function just as the deformed dielectric between the two armatures of the condenser of the electric resonator, and thus be constrained to produce the attraction of each spermatic half element to the corresponding half element of the ovum. And this would have as a final result an energetic reciprocal attraction between the ovum and the spermatozoon.

"The real cause of the sexual attraction of the two germs, male and female, would then reside in their capacity of *vibrating in unison*. Conversely, the absence of all attraction between ovum and spermatozoon belonging to animal or vegetable species distantly related would be due to the fact that they would represent potential half elements, of which there would be too great a number, for

[12] Hartog, "Problems of Reproduction, etc." *Contemporary Review,* July, 1892, esp. pp. 94-95, 100-102.

example in the spermatozoon, completely different specifically from those of the egg, and they could not possibly, therefore, have the same rhythmicity.

EXPLANATION OF KARYOKINETIC CELL DIVISION.

"As to indirect or karyokinetic cell division, let us note that, when each of the two coupled accumulators, in consequence of the continual increase of its mass attains too high a potential, the two halves of each of these accumulators will tend to repel each other, just as would, for example, the two halves of a conducting sphere or disc, charged with too great a quantity of static electricity of the same sign.

"If we admit at the same time, that the separation of the two halves of each accumulator would break abruptly the circuit of oscillation, as would seem indicated by the rupture, retraction, and disappearance of the meshes of the nuclear reticulum during mitosis, and thus suspend temporarily the oscillating discharge, then the nervous energy of this discharge being still at that instant in a dynamic state along the same circuit of oscillation will remain no longer actual energy, but on the contrary becomes transformed into potential, and discharge itself upon the first little bit of substance most capable of receiving it. And this substance, likewise, when once charged with static nervous energy of the same sign must divide also into two parts and thus must form two distinct centers of attraction which mutually repel each other. Consequently, without pretending thus to be able to penetrate into the smallest details of this phenomenon, we understand nevertheless how vital phenomena of *dynamic* order, which are due to the oscillating nervous discharge, must then necessarily be followed by phenomena of *static* order, quite similar to the corresponding phenomenon which the oscillating discharge of an electric resonator would offer, if its oscilla-

tion being suddenly interrupted it discharged itself straightway upon any heap of conductive metallic filings which it encountered, transforming itself from dynamic to static electricity.

"This view would find support especially:

"1. In Delage's observation that in indirect division the longitudinal splitting of the chromosomes or of the nuclear filament begins before achromatic filaments are present which are capable of exerting upon them any pull whatever, from which it may be inferred that it is repulsion which operates between the two halves;[13]

"2. In Hansemann's observation, that during karyokinesis all the peculiarly vital functions of the cell, as assimilation, secretion, etc., are completely suspended;[14]

"3. In Watase's observation, according to which the centrosome in reality is only a simple cytomicrosome but of greater circumference and greater force of attraction, and that the cytomicrosomes which always lie at the meeting point of three or more cytoplasmic fibres, likewise are nothing else than small clumps once quite aspecific which form anew in each cell division and from which arises the contractile substance of the cytoplasmic fibres themselves;[15]

"4. In Ziegler's experiment, in which the poles of the horse-shoe magnet took the place of centrosomes and acted upon iron dust strewn upon a thin horizontal wax plate upon which previously pieces of iron wire of forms similar to that of the chromosomes had been placed, and in which figures were obtained which were quite similar to those presented in nuclear division, which is a direct proof of the conception already advanced by Roux, that in the attraction exerted by the centrosomes upon the chromo-

[13] Delage, *De l'hérédité* etc., pp. 149-150.

[14] Hansemann, *Studien über die Spezifizität, den Altruismus und die Anaplasie der Zellen,* p. 10.

[15] Watase, *On the Nature of Cell-organization,* Boston, Ginn, 1894, pp. 92-93; and *Origin of Centrosomes,* Ginn, 1896, pp. 282, 285.

somes there are in play static energies of nature similar to that of magnetic force or of static electricity."[16]

The hypothesis which Rignano suggests seems, then, to show how very many of the characteristic phenomena of living beings may be scientifically explained. It is a simple hypothesis, based directly upon properties of physical energy which are well understood. The additional specific properties which it attributes to vital energy, seem to be quite in accord with the properties of physical energy so far as they are known, and to be such as they might, under certain conditions, be expected to present, seem also to be very directly indicated by certain biological processes, especially by memory and ontogeny.

The great reason why it must be very seriously considered, lies in the fact that it explains so much which heretofore has seemed beyond the reach of explanation or even of speculation. Assimilation, rhythmicity and periodicity, mitotic division of cells, fecundation, memory, ontogeny with its orderly repetition of ancestral forms, heredity—these phenomena, the most fundamental and constant of all those manifested by living things, have been just those most difficult to explain. Biological details have been thoroughly worked over. The vast store of observations upon them, and upon the modes of action of the fundamental vital processes, constitute the science of biology to-day, but upon the essential nature of the productive cause of all the varied phenomena of life, biology is relatively silent. The problem has been so difficult that by many it has been hopelessly abandoned, though surely hints of the solution must come up before us constantly in our daily work, if we could but understand them.

[16] Ziegler, "Untersuchungen über die Zellteilung," *Verhandl. der deutschen zoologischen Gesellschaft*, Leipsic, 1895, pp. 78-83. Roux, *Ueber die Bedeutung der Kernteilungsfiguren*, Leipsic, Engelmann, 1883, p. 18.—Marcus Hartog, "The Dual Force of the Dividing Cell, Pt. I: The Achromatic Spindle Figure Illustrated by Magnetic Chains of Force," *Proceedings of the Royal Society*, B, Vol. 76, 1905, esp. pp. 555-559.

Some have referred the vital process to the action of spirit, shelving the problem in so far as science is concerned as unreachable and unknowable. But its study constitutes, as Rignano truly says, the real end and aim of all biological study, none of which is without direct relation to it. The conceptions of a few great naturalists have been beacon lights, guiding the course of others, but the fundamental causes are still in darkness. These causes must be sought in the borderland between physical science and biology, and here the help of the physicist is valuable and indispensable, especially if like Rignano, he is able to see clearly in what the fundamental problems of biology consist, and is able also to think synthetically.

The hypothesis contributes to science a basis and guide for further constructive thought and work, and as such cannot fail to fulfil the modest hope of the author that it might be a *travail d'approche* toward true conceptions. And as such it is being gratefully received and carefully considered by many who are still hopeful that these things also will be clearly seen and understood.

Rignano concludes his book by saying that he will be especially grateful to those biologists who will be so good as to send him criticisms or objections, and also to advise him of new facts which can be adduced either for or against his conception.

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MONTGOMERY'S PHILOSOPHY OF VITAL ORGANIZATION.

A MONISTIC philosophy that finds idealism and materialism alike inadequate as interpretations of nature, and which essays to shift the entire epistemological structure upon a new and naturalistic foundation is offered by Edmund Montgomery in his latest, and perhaps final, utterance, *Philosophical Problems in the Light of Vital Organization.* (G. P. Putnam's Sons, New York and London.)

An ontography is here formulated which will go far, its venerable author hopes, to recover philosophy from its forlorn driftings on the unpathed and harborless seas of metaphysics. He beckons back the thought from its wanderings in these intellectual infinitudes, and bids it find in the most intimate and familiar of all things, the human organism, with its phylogenetically developed memory and conscious content, the veritable harbor of ultimate knowledge. Philosophy, he asserts, must reach its truths through physiological and not through speculative investigations.

Such an hypothesis, because of its revolutionary character, can scarcely fail of securing the attention of those whose thought is devoted to either scientific or philosophical interpretation.

Montgomery has covered wide reaches of speculation. Gathering data from the four corners of the philosophic firmament, he has focalized his findings in the individual

microcosm, declaring that in the human organism are to be found, wrought by vital interaction with its surrounding medium, such neural refinements of the ectodermic structures as to harbor all the initiating marvels of man's mentality. "Solely through close attentive investigation of what is revealed in perceptual awareness regarding the organism and its functions," says Montgomery, "can be gained an understanding as to how the living substance or organism comes to be alive, by what means it has structurally and functionally developed so as to stand in definite, manifold interactive relations to its medium, and which of its structures and functions are concerned in the harboring and issuing of its conscious content, in the acquisition of its accumulating and latently preserved experience, and its conduct of life through guidance of such gathered experience." (*Philosophical Problems* etc., page 329.)

With rare dialectic skill, and with an array of all known pertinent facts of physiology, to which he has superadded much valuable data as result of personal, scientifically conducted investigation along biological lines, he essays to demonstrate that there is a veritable physiological seat or source of those potential efficiencies which, stimulated into activity, resuscitate our evanished, though latently enduring experiences imprisoned in the silence and the glooms of the subconscious. Are we, indeed, to hope that science will yet trace the processes which vitally alchemize within the mysterious plexus of the living structure the fleeting phantasmagoria of conscious states, and organize them into the synthetized bodies of conceptual knowledge which we denominate reason with its "universal principles," its "categories," its "ethical imperatives," its "*a priori* mathematics," its "logical norms"?

Adopting the basic postulate of idealism, Montgomery recognizes consciousness as our only direct source of per-

ceptual and conceptual revelation: sense-effected on its objective sides, there is revealed, albeit only symbolically, a universe of abiding, though everchanging, sense-stimulating, substantial efficiencies. Upon its subjective facets arise memories, concepts, volitions, emotions and all the deliverances of our apperceptive faculties.

The forcelessness and purely subservient character of consciousness is strenuously insisted upon, it having, he maintains, "no other significance than to render the living being aware of his organically ingrained modes of interrelation with that which constitutes its real extraconscious environment."

But here, let it be said, the reader loses the very essence of Montgomery's thought if he permits himself for a moment to forget that, to our author, the great extraconscious, perception-compelling entity which we call the external world, including our own being, is only vicariously known to us. What consciousness presents as perceptual realities are fashioned from the radiated influences of force-endowed existents subsisting outside mind, and translated into mental simulacra by means of the functional activities of brain and specialized nerve-structures, themselves the developed creatures of this interplay.

But Montgomery's world is not the world of the idealist, for to him a not-I assuredly exists, though only emblematically revealed. To this contention many a paragraph of his writings is devoted. "*Perceptual* mind," he says, "is altogether moulded on the foreign powers which appear to us as the outside world, and has therefore no meaning save in relation to those outside powers. *Conceptual* mind, in its turn, is significative of those perceptual realizations, and has no value but in reference to them, and the natural and genuine field of exertion for our will, its objects of desire and aversion, lie likewise in the world of foreign existents outside our individual mind. Thus not

only our bodily organization but our entire mental constitution is fashioned in correspondence to a complex world external to our own being." (*The Index*, Oct. 9, 1884.)

Thus unequivocally does Montgomery exclude from his neo-vitalistic credendum all implications of transcendental endowments miraculously infused into the organism. With kaleidoscopic shiftings of the tenets of idealism, he attacks them from every conceivable viewpoint, while materialism suffers no less vigorous assaults from his dialectic "big stick."

It has been one of Montgomery's chief endeavors to demonstrate the unity of the organic individual, and thus to controvert the dominant theory of biologists, which maintains that all organisms, vegetal and animal, are animated not by the vitality of a unitary protoplasmic substance, but by a plexure or aggregation of more or less autonomous elementary cells, plastidules, micellae, gemmules, pangenes, biaphores, physiological units, or whatnots,—not by an indiscerptible plasmogenic being, but by morphological units, almost undifferentiated, working with hyperintellectual endowments to execute the interdependent functions of a complicated living structure.

In short, Montgomery contends for a panzoism that regards the organic being as bioplasmically unitary—a synplasm, and a quasi "entellechy," possessing "the inherent activities of agencies specifically operative in the production of all vital phenomena." He undertakes to demonstrate scientifically and epistemologically that consciousness and all psychic exhibits whatever are dependent upon specific conditions of the vital organism as wrought by interaction with its environment through ages upon ages of vital toil and adjustment.

These specific, synthetized neural congeries possess, he asserts, the intrinsic, though phylogenetically acquired, properties which actuate the faculty of developed aware-

ness, and condition its deliverances by referring them to the mnemonic thesaurus of the subconscious. He finds also in this "intraconscious, microcosmic world," with its marvelous self-reintegrative efficiencies, an answer to the ancient enigma of identity amid change, and a solution of the perennial problem of substantiality. In this same protoplasmic substance, structured functionally into persistent organization, he detects "the abiding matrix that harbors within its trans-phenomenal, extra-conscious recesses accruing experiences, as memorized and systematized knowledge."

Thus, in the specialized sentiencies of the vital organism, and as a result of its physiophyly, appears that psychic radium whose mutating identity, ever renewing, ever disintegrating, radiates all mental activities, re-absorbing each fleeting mode of consciousness, and, touching it with the immortalizing alchemy of memory, relegates it to the under-world where abides the "ingathered Past"—the great Subconscious, to whose marvelous functions Montgomery, more than any other philosopher, assigns the vast importance attaching to them as data of a correct epistemology.

Reason, he says, is inseparable from socially acquired language, so that, with all its manifold deliverances, instead of being a world-creating entity or demiurge, as proclaimed by idealists, it is assumed to be a forceless by-product of perceptual activity and sensorial elaboration, wrought through age-long social and linguistic association, and not an *ab extra* creative importation from transcendental realms, projected through an undiscoverable mystical medium.

This, in its boldest and most sensational features, presents the work to which Montgomery has devoted a long life of patient toil. As this article, by editorial request, is to incorporate somewhat more of the personal element

than is usual in *The Monist's* reviews of philosophic works, something should be said of Montgomery's unique literary style, a feature which elicits either the ban or the enthusiasm of the reader, according to his temperament.

In Montgomery's mental processes there is neither hiatus nor elision. His very coherency subjects him to the charge of over-elaboration. His intellect possesses a sort of alkahestic quality. No composite entity but breaks under his mental catalysis, and his sense of continuity seems to dissuade him from dissipating his thought into such grammatical individualities as sentences, for he ramifies his theme with clause after clause, in bewildering profusion, till a sentence extends sometimes through a score or more lines of his book, and mental continuity well-nigh exhausts itself in wending the verbal causeway he throws across his thought.

His diction is essentially poetic, because, with trenchant insight, he explores the very soul of his thought, and because he adopts purely literary forms of expression, even paraphrasing technical terms wherever possible, thus incidentally rendering philosophy a unique service. In the elucidation of his own theories he has practically developed a special Onomatology.

There is thrilling suggestiveness in some passages of Montgomery's writings as they dart their illumination over uncharted reaches of nescience or into murky nooks of nature's arcana. This is because to Montgomery nothing seems conventional or familiar. He stands before his thought with an awe and intellectual alertness such as Plato ascribes to his imagined cave-creature, who, reared in subterranean glooms, was nurtured to intellectual maturity, emotional normality and sensorial completeness, then led forth to behold for the first time the splendors of a sunrise. There are instances, it is true, in which Montgomery seems to literally revel in linguistic intoxi-

cation; but an attempt to reduce the thought to greater verbal sobriety would result in disappointment. Professor James in a late *Hibbert Journal* has said of Hegel: "His passion for the slip-shod in the way of sentence; his unprincipled playing fast and loose with terms; his abominable vocabulary, calling what completes a thing its negative, for example; his systematic refusal to let you know whether he is talking logic or physics or psychology; his deliberately adopted ambiguity and vagueness, in short, make his present-day readers tear their hair out in desperation." Contrast this intellectual insincerity of Hegel with the intensity and propagandic vehemence of Montgomery, and we find at once the cause and justification of his affluent utterance. Idiosyncrasies and mannerisms of expression are not lacking, but these are easily mastered.

His subtle and intuitive grasp upon the salient features of a philosophy or school of thought is notable. In the alembic of his mind the essential components of a theory loosen from their superadded composition and move, almost with the accuracy of chemical affinity, into their proper places in his conception. An illustration of this faculty will be found on page 101 of his *Philosophical Problems*, where he specifies the dialectic subterfuges and fantastic subtleties to which philosophers have been driven in efforts to square their postulates with the psycho-physical entanglements presented by the interaction of body and mind.

In the year 1852 Montgomery matriculated at Heidelberg as a medical student. His range of acquaintance even then included many of the representative thinkers of Germany, association with whom, owing to their conflicting views, served to thrust our young student into a bewildering vortex of world-interpretations. Under the sway of Moleschott and Vogt, medical science was being delivered mainly in terms of materialism, these eminent teachers

having recently disavowed the conceptual vagaries of Oken and Schelling. But the enthusiastic exposition of Fichtean phenomenalism and of Hegelian ontology as proclaimed by his friends Christian Kapp and Kuno Fischer almost diverted our student from the philosophical faith dominant amongst the expounders of his chosen science. As a counter-check to his idealism, extended conferences were held with the celebrated Ludwig Feuerbach, who, after renouncing Hegel's solipsism, had become an ardent believer in the real existence of sense-revealed perceptible nature. Already Montgomery had read Schopenhauer, and remembered his remark that materialism was fit only for barber apprentices and apothecary assistants, a view gleefully endorsed by most of Montgomery's philosophical friends. But ever the old psychophysical riddle haunted his thought. If no kind of matter can produce or secrete thought, how is it, conversely, possible for any kind of thought to produce matter? The existence of the body is quite as certain as is that of mind. Can they be one and the same entity? Is this tangible and visible body the external aspect of the same existent that reveals itself in intangible and invisible modes of mental awareness?

Experience in the dissecting-room at Heidelberg forbade assent to this theory. The bodily structure remained before him concrete and visible in all its features. The mind, however, had departed, or rather had become wholly extinguished. Mind, therefore, must be something radically different from body. His medical tutors assured him that the body consists wholly of inert material particles mechanically moved. This being true, is there not a wide and essential disparity between it and mind? Nevertheless their interaction was undeniable, though a feeling, thinking mind could not be conceived of detachable from a body in which it had come into the world, and with which it had correspondingly developed from infancy to

maturity. Are then the manifestations of mind and the activities of the body, being experienced as inseparable, concomitant and complemental, to be regarded as only different modes of one and the same entity or individuated being?

Descartes had introduced into biology the prevailing mechanistic and materialistic views of vital processes, and shortly after Montgomery's school days Dubois Reymond and Huxley demonstrated conclusively that mind and mental phenomena only ineffectively accompany the body's mechanically-moved activities without having the least influence upon them. About that time the famous dictum was formulated declaring that brain secretes thought as the liver secretes bile. Physiologists were also proclaiming that thought is accompanied with cerebro-molecular agitation, and the world's best intellects were engaged upon the problem of how the constant and manifold intercommunication of two such incommensurable entities as mind and matter is effected.

The occasionalism of the Cartesians; the absolute, all-involving Substance of Spinoza; the Preestablished Harmony of Leibnitz, and other equally fanciful hypotheses were then engaging the serious thought of philosophers. Descartes had bisected nature into two substances, an unextended thinking substance, and an extended material substance. Intercommunication between two such disparate entities was, however, utterly unthinkable, for how can an unextended substance enter into intercommunication with a spatially-divided or extended entity? Besides there is nothing more surely extended in the world than perceptual vision; yet this is a manifestation of the very entity which is declared to be unextended.

In positing his Absolute Substance, Spinoza failed to disclose any reason why the order of thought should correspond or be identical with the order of things. The

Preestablished Harmony of Leibnitz seems too fantastic to justify even an analysis in this day of severe thought. His "two-clock" conceit serves only to loosen the brow into smiles. Body and mind actually do work in harmony, and the harmony is preestablished, following from the first prenatal movement till death brings a period to vital manifestations. But in all these philosophic postulates there is not a scintilla of explanation given as to how the harmony was established and how it accomplished its results. Primordial fatality or divine fiat were the alternative answers open to the interpreters of these irrational speculations.

The world-creating power of mind, exerted as will or thought, was, in these early days of Montgomery's scientific studies, receiving more serious consideration than was any materialistic view. Kantian transcendental conceptualism, Hegelian ontology, Fichtean solipsistic idealism, Berkeleyan non-substantialism, with their scores of derivatives and interpretations, were rife in the philosophic realm. "Concepts were declared to be the real enduring entities in the world, the abiding archetypes, or comprehensive universals, of which all other modes of existence are mere perishing copies or particulars." (*Philosophical Problems,* etc., page 20.) But Montgomery detected no creative power in his own will or thought, nor in that of any of the idealistic expounders of conceptual potentiality. The radical difference of nature obtaining between the generally perceptible universe and the world of exclusive subjective awareness constantly thrust itself upon his thought.

At Bonn Montgomery attended the lectures of Helmholtz on the physiology of the senses, at which time Berkeley's theory of vision was discussed, and Montgomery was led to read other works of the great idealist who, as he wrote later, "extended the domain of consciousness by despoiling physical nature of all perceived qualities what-

ever, proving that every thing which is realized as perception is of necessity a mental phenomenon." Previously Locke had demonstrated that colors, sounds, odors and tastes were subjective or conscious phenomena and not properties of external existence. Kant had reasoned time and space into mere modes of thought. "After such complete draining into the sphere of consciousness of everything which seemed to make up physical nature, it became doubtful to philosophically trained minds," says Montgomery, "whether there exists, in truth, anything in the world save consciousness itself." But unlike our Huxleys and our Tyndalls who eventually took refuge in idealism, being unable to solve the psychophysical riddles of being, Montgomery made his escape, figuratively speaking, through the back door; for, pondering on the respective parts body and mind are playing in seeing and hearing and in sense-perception in general, he realized that if everything which appears perceptually is of ideal and not of material consistency, then, conversely, it must also be true that nothing mental can be itself perceptible.

And here, indeed, is the very pith of Montgomery's world-conception and interpretation. With almost tiresome iteration, the classification of the perceptual and the conceptual is presented to the reader's attention. If we really consist of mind-stuff, is his contention, we should be wholly imperceptible to others, indeed wholly non-existent. We cannot perceive, touch or see another person's feelings, thoughts or emotions; but we can see and touch another's body. What we actually perceive as another body, though itself a mere mental percept, must evidently represent something of a nature entirely different from that of its perceptual image within the percipient's conscious content.

This sense-hidden mental awareness has to be communicated to outsiders by means of bodily or tangible

signs through sounds, sights or gestures. And the meaning of these signs must be interpreted by the observer's own connatural experience. That which, through sense-stimulation, arouses in beholders a definite percept is characterized by Montgomery as a "power-endowed, relatively permanent entity," while the aroused percept within the conscious content is itself only a feature of "the panoramic play of our fleeting modes of awareness"—a forceless, evanescent ideal phenomenon. The former has power to affect the senses in definite ways, and is hence called "physical" in radical contradistinction to the forceless mental state called "psychical." In this light, Montgomery thinks the problem of psychophysical parallelism becomes intelligible: the mental awareness forms the psychical half, while the observer's sense-imparted perception can be regarded as the physical half of the parallelism. But it must be observed that the same vital process which awakens in the subject a definite mental phenomenon, and elicits corresponding physical expression, evokes through sense-stimulation, in the beholder, accordant motor signs. The perceptual awareness of these physical tokens is just as much a mental state as is the subject's imperceptible ideal phenomenon. The term "physical," then, in this connection, means the external, sense-compelling influence which affects in definite, preestablished ways the beholder's receptive sensibilities, and forces the presence, characteristics and activities of its source of emanation to reveal themselves in mental representation.

It must be remembered that in Montgomery's epistemological system, everything is trans-phenomenal except awareness and the actual content of consciousness, present or memorized. Hence all activities that can cause conscious states to arise, whether of the perceptual or conceptual order must be regarded as extra-mental, that is, external and physical. He says (*Philosophical Problems*, etc.,

page 145): "These extra-conscious activities, resulting in mental occurrences, are set going in the same power-endowed sphere wherein our enduring self and its matrix of consciousness have their real being. These specific activities of the organic being are, consequently, as such, unknown processes, processes taking place outside conscious awareness. They are, however, definitely signalized by the specific conscious state to which they respectively give rise." And that which evoked the conscious state is henceforth preserved to reissue its efficiency as a memory upon appropriate stimulation, all this occurring in the organic realm beyond any possible control of consciousness, which indeed is only the interpretative outcome of these processes. And this is also the explanation of the phenomenon of volition or self-determination, a subject to which Montgomery devotes much attention.

Sense-stimulated awareness is strictly compulsory. Its content cannot in substance be volitionally changed. But there is another set of mental phenomena more intimate than that revealed by physical stimuli: it is the realm of past experience systematized and memorized. This submerged world can reappear in consciousness independent of sense-incitement. Sense-awakened mental states, however, cannot appear without carrying with them, or, perhaps, more correctly, concomitantly eliciting, as interpreters, a wealth of complemental data from memorized past experience. And this is one of the most remarkable facts of psychic life. Some synthetizing property, doubtless having its basis in neural or cephalic structure, appears to be a function of the organism, as is regeneration. Somewhere and somehow within the recesses of the encephalon this synthetizing function is ever carrying on its wonderful processes, and returning its product in systematized and therefore available memory of affiliated past experiences.

The transference of epistemological problems from the

realm of metaphysics to the domain of biology was first essayed by Montgomery in discussions with Helmholtz, and somewhat later advanced in a German work entitled *Die Kant'sche Erkenntnisslehre widerlegt vom Standpunkt der Empirie.* This rather elaborate attack on Kant's doctrine of the *a priori* bore the subtitle, *Ein vorbereitender Beitrag zur Begründung einer physiologischen Naturauffassung,* and one of the chapters carried the rather startling title: "The Necessary Synthesis of the Sensible Manifold is a Physiological and not a Logical Action." The following passage from that work gives, perhaps, the earliest enunciation of a philosophy based upon vital organization: "The solution of philosophical problems is to be found only by way of physiological investigation. Every philosophical question, rightly put, is a physiological question. We know that an organ repairs the waste it suffers in functioning; that it restores itself to a state identical with its former self without being assisted thereat by anything mental. Thus it becomes unconsciously capacitated to perform anew identical functions. It is this entirely organic process which underlies all consciousness of identity, and certainly no spontaneous power of the transcendental Ego, as assumed by Kant." (Pages 125-6.)

Another fact of nature which in Montgomery's philosophy is deemed of paramount importance, is that actual awareness takes place only in the real present, a mode of time radically contradistinguished from the future and the past. These present moments of awareness follow each other uninterruptedly, passing away in "dissolving waves of ever-lapsing Time," as Montgomery poetically says. If the evanescent content of past moments of awareness were not available to present consciousness, complete oblivion of everything previously experienced would prevail. As the content of these past moments of awareness cannot possibly dwell in the transitory panorama of the conscious

phenomena themselves, there must, perforce, be some matrix wherein their memory is enduringly preserved. "Time itself cannot be apprehended, only its freight of succeeding appearances is the object of apprehension. These appearances supplant each other successively. And their definite sequence in time must, then, evidently be necessitated by the definite activity of the underlying substance which issues them into actual awareness. They, therefore, necessarily appear in definite order in subjective or empirical apprehension, because they are thus definitely determined in the realm of substantial existence." And this interrelated, persistent, substantial entity, this extra-mental, power-endowed sphere of real existence is of course the perceptible body. For it must not be forgotten that to Montgomery the living human organism, with its wonderful endowments, is the veritable *ens entium.* It is the basis of his epistemological structure. No notion of "gross matter" inheres in his concept of the visible man. "We touch heaven," said the devout Novalis, "when we lay our hands upon the human body." Montgomery has reared it scientifically to this pinnacle of piety. It is to him "the matrix whence issues into actual awareness in unbroken sequence the panoramic revelation of nature, conveyed in ever-changing kaleidoscopic combinations of sensations, perceptions, thoughts, feelings, cravings and emotions. Such a matrix," he says, "must be in all verity a genuine substance possessing the essential properties with which advanced philosophical thinking has been led to endow the inevitable notion of substantiality: a notion that alone rescues our world-interpretation from complete collapse into the abyss of idealistic nihilism." (*Philosophical Problems,* etc., page 109.) In further defense of the dignity of his conception of organization, he says (pages 197-8): "the visible organic commotion we call life, which is sustaining with its ceaseless activity all structures and all functions

of the living individual, reveals in its incomprehensible potency the profoundly mysterious nature of our real extra-conscious being, fully justifying us in regarding it as the veritable source of the flowing phenomena of our conscious content."

To establish his postulate as to the relation obtaining between morphological structure, its physiophyly and concomitant psychic manifestations, Montgomery spent years of patient toil as a microscopist in the study of proto-organisms. Here he found further reason for opposing the mechanistic doctrines of the physicists, particularly as they applied to vital phenomena and organic deportment. No physico-chemical hypothesis would cover the field, though many of the vital processes formerly classed as purely physiological he relegated to the realm of the chemical and physical. Nor have developments in the meanwhile served to eliminate the necessity of reckoning with an element "not amenable to the ordinary yoke of physical laws." The vaunted doctrine of endosmosis was heralded by Dutrochet as a veritable explanation of life itself. Later investigations, however, demonstrate that the intestines are lined with epithelial cells, themselves independent organisms considerably specialized, and that the protoplasm of these cells selects and appropriates proper nutriment in the same manner as do the ciliate infusoria. And this selective process unmistakably implies a nervous system. The psychical element, therefore, enters at an early stage as a factor in unicellular life; and as a functioning element plays a part in morphophyly not at all inferior to the physico-chemical forces.

What then is this most common and intimate thing called vitality?—"this intangible something whose formative potency draws to itself stray stuff from the visible world, coercing it into significant organic arrangement and prescient aimful activity?" Vitality, Montgomery

avers, is not a static property but the result of a dynamical process. "It is not the property of any kind of mere chemical compound. It is altogether a phyletically elaborated chemical process taking place in strict dependence upon, and interaction with, the stimulating influences of the medium."

As to the origin of life itself, Montgomery, of course, refers it also to molecular processes. He says (*Monist*, Vol. 5, No. 2): "Whenever a complex molecule, formed during the chemical elaboration of our planetary material, suffered slightest disintegration, that is, loss of any of its constituent elements, and was thereupon able to re-integrate itself by means of combination with complemental elements offered by the medium, there life had its beginning, . . . for its alternate disintegration and reintegration raised it from the sphere of lifeless existence into that of living activity."

That the protoplasmic individual is a chemical unit, Montgomery has discussed in an article entitled "The Dependence of Quality on Specific Energies," published in *Mind*, 1881, wherein he essayed to demonstrate that no number of qualitatively equal units can possibly, through any kind of aggregation or juxtaposition, produce by such summation anything qualitatively higher than themselves; no number of mere aggregations in whatever special position a higher chemical compound; no number of mere aggregated organic molecules a living organism; no number of merely aggregated elementary organisms a higher organism, and no number of merely associated psychical elements a higher mental phenomenon.

Mayer, as a corollary to his doctrine of the correlation and transmutation of forces, had proclaimed that vital activity was solely a display of transmuted physical forces, sustained and perpetuated as such by mere combustion of the appropriated nutriment. Muscle was only "a machine

through whose instrumentality is brought about the transformation of force.... It is not itself the material by means of whose chemical metamorphosis the mechanical effect is produced." Montgomery was amongst the first to attack this unphysiological view of vital organization, and in articles published in Pflüger's *Archiv* (1881) he announced his position after exhaustive studies of motility in micro-organisms and in muscular fibre. His claim was to have demonstrated that the force effecting vital movements is in reality "mass-manifestation of a definite cycle of chemical activity, occurring in the very substance which exhibits the motion."

Minimizing the importance generally attached to morphological appearances in biological study, Montgomery discarded the use of powerful re-agents in the examination of the visible details of organic structure as employed by Virchow and his school. He examined tissues in serum and, where possible, in their natural living state. Investigating microscopically in living muscles their structural movements, he found the striped protoplasm of such as had been detached from the body of insects, when immersed in distilled water instead of serum, to be suddenly converted throughout into fine, wavy, fibrous tissue similar to that of tendons. Then followed the rather startling discovery that this complete disarrangement of the striped structure of the muscular fibre was susceptible to perfect restoration on the addition of a little salt or sea-water, a substance chemically similar to blood. This experiment forced the conclusion that muscular fibre is not stable machinery mechanically moved, but that it consists of a substance possessing its own actuating principle, and that its minute structural organization is due to its intrinsic chemical constitution and the specific vital activity attaching to it.

In the logical development of his attack upon mechan-

istic theories he questioned some of their fundamental postulates, energy and motion themselves being labeled "abstractions." "In the whole range of thought," says Montgomery (*Monist*, Vol. 5, No. 2) "there exists no more fanciful belief than that which makes so utterly inconceivable an abstraction as pure energy or motion detach itself from a moving mass to seize upon another mass which it thereby energizes." The changes which are observed to occur in groups of physical existents are wrought by powers inherent in the interdependent agents thus manifesting the changes. "We become consciously aware of physical existents solely by their sundry characteristic activities stimulating our senses." These activities merely stimulate our senses, observe, not passing over into our being. In like manner motion merely stimulates changes in other physical compounds by affecting the latent energy within their own intimate and inalienable natures. Experiments in catalysis are corroborating these assertions more and more, while observations on the nature of radium have confessedly overturned theories of the conservation of energy. Even the theory of the kineticism of gases must assume in the gas-molecules the intrinsic endowments of elasticity and motion. Energy therefore is not transmissible and interconvertible. It is not only constant as an innate property of physical substances, but it is infinite and inexhaustible. The energy, for example, which manifests itself in this table to effect the visual sense would continue forever to emanate its subtle force without diminution of its stored potentiality. "Three principal facts fatal to the theory of the conservation of energy....are: first, the inseparability of an activity from that of which it is the activity; second, advantage of position due to forcible disequilibration; and third, the intrinsic inexhaustible power possessed by masses to resist and counteract over and over again with undiminished efficiency, within certain limits, any

external disturbance of their equilibrated state." (*Philosophical Problems,* etc., p. 291.)

Another of Montgomery's intellectual battles was waged against the cell-aggregation theories of biologists, in his contention for a purely unitary view of the organism. "The assumption of autonomous cells as aggregated constituent elements of the out and out organized unitary individual, and of the composition of such autonomous cells by a further aggregation of secondary units,. . . .gives rise to painfully labored, illogical theories of vitality and organization, wherein the imagined imperceptible units are, to begin with, arbitrarily endowed with all the properties they are invented to explain." (Page 161, *Philosophical Problems,* etc.) If this theory be true the diversified tissues of organisms must be products of a single reproductive germ-cell by a process of cumulative cell-division.

Somewhere Montgomery thus formulates the riddles involved in these germ-cell theories: "How do the myriads of differentiated cell-beings entering into the formation of a complex organism manage to become potentially represented in the initial germ-cell from which they emanate? and how do the potential differentiations enclosed in the germ-cell manage to evolve the adult organism?" Darwin, with his wonted frankness, fronts his provisional hypothesis of pangenesis with a scarcely less unsolvable enigma: "How can the use or disuse of a particular limb or of a brain affect a small aggregate of reproductive cells seated in a distant part of the body, in such a manner that the being developed from these cells inherits the characters of either one or both parents?" Verily the problems of regeneration and heredity are the fundamental problems and crux of biology; and their solution involves a mastery of the mysteries of the dim world of molecular activities. And here indeed is where Montgomery has sought his answer to the sphinx-riddle; for to him it is the morphological

output effected through chemical reintegration of the protoplasm of the spermatozoid with its inherent vital properties that forms the adult organism.

To Montgomery, protoplasm is not merely an aggregation of molecules preserved as a mass by physical cohesion, but an indescerptible unit, cohering under such specific chemical bonds as distinguish natural compounds. But its vital functions, "due to a definite cycle of chemical activities," operate independently, and involve the entire substance in "chemical solidarity." That vital process which develops the pseudopodium, and which causes it to withdraw again into the emanating substance, depends upon chemical avidity for restitution. Assimilation is merely reintegration through combination with appropriate pabulum, and this process, of course, involves the necessity of eliminating waste material. This final act in the catabolic process is accomplished by means of depurative vesicles. Assimilation does not involve on the part of the living substance a metamorphosing of the appropriated material into separate vital beings like itself, as generally believed.

Montgomery thinks this account of the constitution of the organic being lends itself readily as an explanation of the problems of reproduction. His experiments in ontogenesis verified this conclusion. He sliced into many parts the rather highly differentiated stentor, each of which parts developed a complete adult trumpet-animalcule. And this morphological restitution was accomplished, he asserts, "by dint of its unsaturated chemical affinities managing by degrees to reconstruct, through assimilation of complementary material, the chemical whole of which the fragments formed a part." Metabolism finds here, then, a proper and scientific explanation, as do fissiparity, the "budding" process, and all other forms of organic regeneration.

This, it must be confessed, simplifies matters encouragingly; but observers of karyokinetic phenomena and

other processes of fissiparous division of cell-nuclei will doubtless regard it as inadequate. It must be admitted that Montgomery's direct methods eliminate many of the difficulties injected into the problem by the cell-aggregation hypothesis. It would seem, however, that he is not wholly free from the philosophic vice of other biologists, so trenchantly attacked by him in referring to their "surreptitiously smuggling" into physiological units such plasomes as were required to potentialize them with their requisite characteristics. Montgomery's philosophic sins are not so subtilly devised. They consist of attributing to phyletic processes the development of qualities apparently incommensurable with the physical, chemical and vital substrata of his evolving substance. Memory and awareness "intrinsically originate" from protoplasm, in which they, in weak diffusion, inhere in the same manner as physical and chemical properties inhere in non-vital substances. Their progressive sentient and conscious modes are then phyletically developed outcomes, and structurally incorporated. The sublimation of that chemical reaction known as "irritability" into thought and the interpretation of relations between thoughts, seems a far leap. But his refutation of the theory of functional indifference of structural elements, as advocated by Lewes and Wundt, went far toward establishing his theory that all vital reactions are attributable to the intrinsic endowments of their living substance and its specific structural organization. He further fortified his position by devoting years of study to protozoic organisms, the results of which were published under the title, "The Unity of the Organic Individual" (*Mind*, 1881).

In this valuable contribution Montgomery explains how the all but homogeneous protoplasmic individual becomes developed into higher organism by reason of its substance being differentiated into a set of interdependent structures which become more and more developed. In transparent

Protozoa the whole cycle of activities in which vitality consists can be directly observed in its entirety and simplicity. The vital process brings nearly all the organism into interactive contact with the stimulating influences of the medium, and preserves its integrity and efficiency unimpaired. Moreover it leads to structural development, for function develops structure.

And here is the foundation of Montgomery's biological system. Primitive functions are phylogenetically elaborated. Structure concomitantly develops: not through conative or conscious processes, but through the activities of the complemental, stimulating, non-mental power-complexes beyond the conscious content,—entities which possess, he says, an apparently "creative trend." The muscular development of the athlete is no whit the result of any mental deposit. It is the inevitable effect of a transphenomenal creative activity of which consciousness and all mental processes are also manifestations. "Our fitful and fragmentary consciousness is not at all concerned in the never-flagging, vital activity whose toil alone maintains intact the high-wrought possessions of life."

The continuity then of organic life is strictly dependent upon "the maintenance of structural integrity and functional efficiency." Upon this rests the stability and consistency of the world as revealed in consciousness, and the preservation of our gradually acquired experience; for this latently retained and automatically memorized nexus of past experience has become inwrought into the ectodermic structures. Without this systematic structural fixation of the content of the past, there could exist no connatural experiential formulae, no conceptional consistency, no logical integrity, no formulation of universally valid concepts, no categories, no norms of reason, no truth. It is this structural identity, maintained despite changeful events and the experiences of manifold varying actions performed

and re-performed, that constitutes, according to Montgomery's creed, the veritable substance, which, as before stated, philosophers are driven to postulate in order to secure an unimpaired "issuing matrix" and a perduring support for the perpetual flux and identical re-issue of conscious phenomena. There is no other actually known substance that meets the philosophic requirements, for no other has the power to preserve its identity while emanating the changeful pageantry of the physical cosmos or of the phenomenal world of consciousness.

Looking then upon the human structure, so minutely and so significantly organized, Montgomery finds both biology and philosophy compel him to recognize it as the veritable entity in whose being the representative world of consciousness has been toilsomely fashioned in symbolical revelation. For here again let it be remembered that the perceptual mind deals only in symbols which but meagrely represent the transphenomenal entities of the real world. The images into which are translated the "ethereal vibrations" impinging upon our specifically attuned sensory substance can possess no qualitative parity with the extramental excitant of the molecular composition of the neural-threaded sense-organ. What the real character of this external, sense-stimulating, changeful but perduring entity actually is we have no powers for determining. But certain it is that within the vitality-touched fragment of the great external world which we call our body is fashioned the issuing matrix of consciousness, and all the mental activity which delivers our world-revelation.

Whatever intellectual giant man may prove to be here in his own sphere, he is, in reality, but a cosmic pigmy who owes all his gifts to creative powers incomprehensible to himself, and incommensurable to his own faculties. The belief in the nature-constituting efficiency of one of her late manifestations has led philosophers astray ever since

divine Plato elevated reason to supreme power. Philosophic problems have ever since been treated deductively from conceptual premises intuitively derived, mainly by assigning to hypostatized abstractions creative potencies, and regarding them as real objective existents. It is, however, becoming more and more evident that concepts are mere subjective, transitory mental representations of organized and synthetized actual experience, which must be scientifically verified as corresponding to conditions naturally given before they can serve as reliable data for reasoning processes.

Hume and Kant perceived that analytical propositions cannot enlarge our knowledge of reality; but they failed to discover how synthetical, knowledge-enlarging experience had wrought upon reason. Habitual association of given particulars, as Hume reasoned, or mind-made synthesis of given appearances, as defined by Kant, fails to give to concepts their necessary character of permanency. According to Montgomery the explanation lay in the fact that during the interaction of the organism with its physical and social medium, newly acquired experience becomes "creatively incorporated" into the structural matrix which preserves past experience, the entire organism being, in every detail of structure, a perceptible record of its entire racial experience. Concepts are therefore nucleated bodies of thought organically synthetized subsuming apprehended similarities, and lending themselves to "analytical judgments and dialectic evolutions in elucidation of experientially accrued knowledge." (*Philosophical Problems,* page 12.)

Thus at a considerable expenditure of mental effort, Montgomery refutes all conceptualistic theories that assign to intelligence creative potency. "Neither Plotinus nor Spinoza, neither Scotus Erigina nor Schelling, neither Leibnitz nor Hegel have, in their various attempts, in the

remotest degree succeeded in showing how the world of direct, actual experience can in any way be evolved from an ideally constituted Absolute, or indeed from any kind of ideally conceived substance." (*Philosophical Problems,* etc., page 21.) The "psychical force," a self-emanating activity postulated by Leibnitz, evolving its phenomenal products out of "an unsubstantial void," and the "hypostatized beingless abstraction" to which Fichte's non-substantialism reduced the creative agency are shown to be worthless as epistemological data. Spinoza's Substance is but an arbitrarily endowed essence of all potentiality, which Montgomery likens to pure white light potentially comprising all colors. "But," he asks, "whence the activity, the power that shapes the definite form, that breaks the single white radiance into variegated multiplicity; that segregates from homogeneous all-comprehension the special attributes of 'thought' and 'extension' which are held to constitute our world?" No answer is afforded, he says, by any absolutistic ontology. "Divine substance refuses rationally to tear its perfection to tatters. If it does so 'irrationally,' as Schelling maintains, it then becomes guilty of all the pitiful insufficiency that, then, follows from so degrading an action. Schopenhauer's pessimism is the consistent outcome of such a conception." (*Philosophical Problems,* page 24.)

Montgomery's own naturalistic conception of Substance, then, affords a relief from the rarified subtleties of the metaphysicians. Reason or intelligence in whatever form objectified or hypostatized, is possessed of no creative efficiency. Its sole function is that of rationally assisting the organism to adjustively meet the conditions of a social and physical environment. This ability is connaturally and concomitantly developed with its phyletic evolution, its increasing enlargement and specialization of

function being permanently and availably inwrought in structural exponents.

The ethical creed deduced from these naturalistic premises, with much else of interest, must be left without comment. Montgomery's books and papers should find a permanent place in philosophical literature. Sometime they will be credited with yielding an illuminating glimpse into the profundities of Nescience.

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CRITICISMS AND DISCUSSIONS.

"SELF-REALIZATION" AND THE WAY OUT.

As a theory the ethical doctrine of the English transcendentalists is reconstructive rather than constructive. Since Green's "Prolegomena" we have had from them nothing in the way of new and positive principles: at the most they have given us the formula of "self-realization," which they have derived altogether by criticism of the historical types of ethical theory. Though they differ from their predecessors in a more scientific psychology, better method, nicer illustration and finer literary style, they are still at the meeting of the ways, because they mistake a secondary for the fundamental fallacy in hedonism and rationalism, and thereby perceive not an original constructive point of departure for their own doctrine.

That fallacy is not, as the English transcendentalists take it to be, the sacrifice of the integrity of the self, on the one hand to sensibility, on the other to reason, but the greater sacrifice of infinite potentialities to an artificial general concept. In this essay I aim to point out the fundamental fallacy in rationalistic ethics, and to indicate a constructive way out for the self-realizationists.

We shall make a poor start if we attend at all to the traditional distinction between sensibility and reason and their ethical values. It is now a commonplace of moral philosophy that rationalism is quite unpsychologically founded. We shall begin well, if for a start we single out a central aspect of the Stoic ethics, against which modern psychology can direct a valid, but ignored, criticism. I mean the rationalistic attitude to "Fortune."

I.

In his *De Consolatione Philosophiae* (Bk. II, cap. 4) Boethius reports Wisdom as saying, "Adeo nihil est miserum, *nisi cum putes*; contraque beata sors omnis est aequanimitate tolerantis,"—which is almost a literal anticipation of Hamlet's reflection, "There's nothing

either good or bad but thinking makes it so." Modern psychology would develop these maxims in two directions. First: human consciousness, which only for analytic and expository purposes may be divided into special parts and separate processes, is the source of all value in the world, of good and evil in every sense. If we were merely automata—and in this day when we have talking machines and walking machines that do human things and feign human ends, the conception is not irrelevant,—conceivably we might come to make all those useful reactions on our environment which we now consciously make, but without thinking, they could be designated useful only by metaphor: to us as, *ex hypothesi*, automata, our environment and all its vicissitudes would be indifferent, neither good nor bad.

Now, by certain inveterate habits of thought, or under certain exigencies of explanation, we abstract from consciousness all its vital and sensitive content until it becomes merely cognitive. Then, forgetting that we have arrived by abstraction at this conception of the human mind as an *intellectus purus*, we submit that from reason alone the world and conscious existence derive all their value. But if consciousness were merely cognitive, we should at best be nothing more than intellectual automata; and thus our environment would be merely a system of mathematically related objects, devoid of all that would make life worth living. Only human consciousness, as phenomenally given in its integrity—cognitive, appetitive, and volitional through and through—can constitute excellence, establish ideals, and create an environment of good and evil.

Fortune, then, has no other origin than this:—it is the offspring, not, as the Stoics conceived it, of foreign and capricious fate, but of our own nature and idiosyncrasy. In other words, fortune is a short-hand term for all those things in the world which satisfy or dissatisfy our vital impulses, which are dear or repugnant to the heart, or delightful to the imagination.

Again: So far this is a very simple and obvious piece of psychology: but because the English transcendentalists, as before them the Stoics, consider only its subjective meaning, they miss its application and value in ethical theory. On the subjective side, while the Stoics saw that by negating the world, that by consciously willing to live without its goods, they could thus fortify themselves against "the slings and arrows of outrageous fortune," they did not see the deeper meaning of this attitude of spiritual detachment from the

world. Carry out this method of exclusion to its logical end, and it must result that there will be *neither a world nor a self at all.*

Modern psychology, on the other hand, taking for its datum the concrete phenomenal consciousness, not only names and describes our psychic processes in terms of the objects on which they function, but views these processes as constituting both the active substance and the content of the self. This is a method of *inclusion,* empirically based. But the inevitable abstraction which results from the subjective method of exclusion, led the rationalists, from the Stoics to Kant, to set up an artificial general concept as the real, essential self. As, in the view of the Stoics, the self could "cut loose" from fortune by denying the real existence of external goods, so, too, the soul could escape fortune by affirming only the validity and worth of intellectual processes as such. Psychologically viewed, this is not losing the self to find it, but finding the self to lose it in an empty form—and nothingness.

Under our analysis, it appears, fortune is but the complex of our possible interests objectified in our material, social and spiritual environment; and the concrete self is the complex of perceptive processes and vital reactions that create our demands, interests and ideals, and constitute the world of good and evil. Not, then, any abstract, formal divorce between sensibility and reason, but the insistence on a real, practical and absolute separation between the substance of consciousness and its content, between self and fortune (not-self),—this is the fundamental fallacy in all rationalistic ethics, from the Stoics to the English transcendentalists.

Let me add, before we proceed, that there is in this no tendency on my part to hark back to subjective idealism or solipsism. For, as we shall see, while the distinction of self from not-self is a function of the process of perception, in practice it becomes a futility and in ethical theory a superstition. The truth the distinction signalizes in ethics needs restatement. But as it stands historically in the system of the monists it is literally, in the Hellenistic sense, a σκάνδαλον,—a stumbling block. When we see how and in what sense this is so, we have found a constructive point of departure for the monistic theory of self-realization. To this we now turn.

II.

The charge of formalism, which the self-realizationists bring against Kant's doctrine may be as justly laid against their own; and, further, their concept of personality, for from being a principle

which overcomes the simple psychological dualism of the rationalists, only results in a profounder dualism. This outcome is altogether the product of certain stubborn incoherences of thought, abetted by an inherited apriorism.

When the self-realizationists work from the dignity and authority of reason—which means that, *a priori,* sensibility is held in contempt—they arrive at the "idea of self" as the constitutive principle of morality. I do not deny the validity and worth of this principle; but I affirm that the constructive principle of morality is no such abstract idea and has no such ground and origin in human nature as the English transcendentalists allege. The authority of reason does not come from itself, but from our irrational nature,—from our despised sensibility and the moral consciousness, of which reason and reflection are a part but the last part. Only a mind sophisticated by idealistic tradition and inveterate abstract reflection can credit reason with more inherent dignity and authority than it grants to sensibility.

If we reduce the matter merely to verbal propriety, it is the truth that far from feeling being, as it is traditionally conceived, the servant of reason, reason is the servant of feeling. But in reality it is so because vital impulse creates first the demand for life and next for rationality in organizing our faculties and energies. In short, the dignity and authority of reason and the rationalistic "idea of self" are but contents of that very consciousness which they are supposed to explain,—ideals which it creates and explains.

If the case stands thus with the transcendental "idea of self," if it is an empty *a priori* form, the self-realizationists must face a still graver charge: their apriorism creates a profounder dualism than anything Stoic or Kantian. We shall better see the truth of this if we observe how a member of the pluralist camp puts the case for the self-realizationists. Says Professor James Seth: "As the watchword of hedonism may be said to be self-satisfaction or self-gratification, and as that of rigorism [rationalism] is apt to be self-sacrifice and self-denial, so the watchword of eudæmonism may be said to be self-realization or self-fulfilment. It seems almost a truism to say that the end of human life is self-realization. The aim of every living being....may be described as self-preservation and self-development, or in a single term, self-realization....Moreover, every ethical theory might claim the term "self-realization," as each might claim the term "happiness." The question is, What *is* the "self"? or, *Which* self is to be realized? Hedonism answers, the

sentient self; rigorism, the rational self; eudæmonism, the total self, rational and sentient."*

Now, I submit, if to the ethical command "Realize thyself," the question keeps the form, "*Which* self?" then we shall only concern ourselves again with the old problem of the *relation* of sensibility and reason in the *individual*, and we shall never thus accomplish anything more than a tentative reconstruction of the broken fragments of the historical types of ethical theory. Positive construction will begin only with a direct empirical answer to the question, '*Who* (or *What*) is my self?' There is in this question no reference to sensibility or reason, or any merely conceived elements or processes of consciousness. For the question starts an immediate psychological investigation of the phenomenal consciousness as such, but soon rises out of its empirical confines into the metaphysical zone, without any violation of scientific method or human nature.

We proceed immediately from an irreducible datum of psychology. The teaching of to-day is apt to describe consciousness in terms of a few familiar characteristics: it is personal, always changing but sensibly continuous, selective, motor, etc. Paramount for ethics is the fact that all these are realized and expressed in another characteristic, namely, that consciousness is essentially *social*. However much theoretical psychology may insist on distinguishing in the process of perception the substance from the content of consciousness, the active knowing self from not-self, or "I" from "mine," we must recognize in practice that these are abstract and relative distinctions.

In its objective references, as well as in its inner essence, consciousness is an *inclusive* activity. Prof. William James rather understates, or too pragmatically puts, this truth. The "sense of the shrinkage [and enlargement] of personality" is, he says, "a psychological phenomenon by itself." It is not, however, so true that the concrete empirical self shrivels or expands, as that it actually *is* or is not, in direct proportion to the number and variety of the objects which appeal to sense and imagination and satisfy vital impulse. The phenomenon is an immediate and characteristic psychological datum. As, in perception, a taste which is not tasted, or pleasure which is not felt, is nothing, so in practice the self is zero if its activities center nowhere, and infinite if they have universal content and direction. The indisputable proof of this is no mere

*James Seth, *A Study of Ethical Principles*, 1st edition (1894), p. 204. The italics in the quotation are Professor Seth's.

pragmatic test, but the sense and emotion of personality in the presence of the world; we actually *feel* ourselves, not only real beings, but also greater or less individualities, according as our world and interests are widened or narrowed, recognized or ignored.

On the other hand, this psychological phenomenon is the first condemnation of the transcendental attitude to sensibility and reason and the disproof of the abstract "idea of self" as the constitutive principle of morality. Only a devotee of apriorism can dignify and sublimate the so-called spiritual processes of the self into a separate and authoritative unity on its own account, and name it *par excellence*—the self. Our bodies, family, possessions, and even our philosophies, no less han our spiritual processes as such, when they are intimately related to our finite organization and felt to be ours, are essentially part of the self.

We are ready now for the application, and for the formulating of our constructive principle. The immanent social function of consciousness—the innate tendency of self to inclusion of all reality—is the fundamental datum which the self-realizationists have ignored. In our view, the real and complete identification of self with universal reality is as much a psychological necessity as a moral ideal. In virtue of this social function of consciousness it is no longer possible either (1) to make self-consciousness idiocentric or (2) to split the universe into self and not-self. Without here at all passing into phenomenalism or solipsism, the ultimate and real distinction is between *the active, appropriating self and the potential self*. And, as in perception the apperceptive content of consciousness is the mind which makes experience from nature (not-self), so in practice the concrete social self constitutes morality from the potential self by appropriation and identification.

This distinction, from our point of view, is as relative and conventional as the distinction between selfishness and unselfishness: the difference is solely one of the universality and objectification of human activities and interests. "O Universe, I wish all that thou wishest," said Marcus Aurelius; and thus by identifying his will and interests with total reality, his own finite self became one with the universal self. This, then, is the constructive way out for the self-realizationists.

That the accidents of our physical nature, and of social and cosmic evolution, prevent the actual absorption of universal reality into the life of the human spirit, has nothing to do with the logical issue. The question, "*Who* (or What) is my self?" is already an-

swered. For objective reality—fortune, material goods, institutions, offices and humanity and God—stands over against the finite self, not as some absolute "other," but as its own potential self. The Absolute, that is to say, is my real and complete self.

I may point the matter familiarly in this way. When we read in the Scriptures that "God so loved the world," habitually we not only misplace the emphasis but also suppose that this act of the deity was wholly gratuitous and gracious on his part. But from the very nature of consciousness as social, anything less than the complete inclusion of the world (i. e., the totality of human spirits) in God's love was impossible. And so must it be in our own case. Anything less than the identification of our finite, actual self with the Absolute, who is our infinite potential self, is logically impossible and morally futile.

To sum up: When the self-realizationists charge the rationalists with reducing morality to formalism, we may justly reply that their own concept of personality is a pure *a priori* product and their "idea of self" an empty abstraction. Their apriorism confines attention too much to the subjective content and meaning of personality, and their maxim, "Realize self" compels us again to ask the traditional question, "*Which* self?" And thus we never get beyond the problem of the relation of sensibility and reason in the life of the individual as such. On the other hand, the inquiry, "Who (or What) is my self?" has a direct empirical answer in the social nature of consciousness. On this datum of psychology as a stepping stone, we may rise without fear of hindrance or contradiction into the metaphysical zone. To be sure, psychology has nothing to say as to whether the universe is a personality or not. But for ourselves, assuming the proof of spiritual monism, "Realize self" becomes a concrete, practical maxim. For although we must wait on experience and social evolution for the knowledge of the means of self-realization, we are always sure of the nature of self and the content of the moral ideal. "Realize self" now means, "In your own finite life fulfil and perfect the life of the Absolute Spirit."

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A TWENTIETH CENTURY ZENO.

In considering any attempt to prove Euclid's parallel postulate, it is well to consider first what is meant by geometrical proof. In

defining some terms by means of others, it is obvious that we must begin primarily with some terms which are themselves *left undefined.* To *prove* any statement is to show that it follows as a logical consequence from relations already accepted, so that we must eventually begin likewise with statements for which *no proof is offered.* These initial statements are frequently called "axioms" but had better be called "assumptions," since we are at liberty to make choice of these statements in any way we please, subject to but one condition, namely, that they must not contradict one another. For an ideal systen. they must be likewise independent—that is, such that no assumption follows as a logical necessity from one or more of the others.

It will be apparent, therefore, that our ability to prove any theorem will depend upon our initial assumptions, and that without a knowledge of the assumptions employed, the proving of a statement is meaningless. Now from very early times it was thought that Euclid's parallel postulate could be deduced from his other assumptions, or, in other words, that his system was redundant; and the different places in the ancient editions occupied by this historic statement would seem to indicate that Euclid himself was somewhat in doubt as to the necessity of inserting it. Thus have arisen the attempts to prove this assumption—that is, to deduce it from his other assumptions; and though all these attempts have failed, they have nevertheless been most fruitful in illuminating the subject of the foundations of geometry. By making *some other assumption* we may easily prove Euclid's; for example, it is now customary to use some such modification of Playfair's assumption as "Through a point without a line there cannot be two parallels to the line." Such substitution, however, is not contemplated in an attempt to prove the parallel postulate.

Conversely, to *disprove* a statement, is to show that it contradicts, or leads to a contradiction of, some other statement logically deduced from the original assumptions. That one discredits a statement is no more a logical objection to it than is one's credence to be regarded as logical proof. One is at liberty to *replace* any assumption of an ideal system by any other likewise independent of the remaining assumptions and evolve a geometry differing materially from the former, the sole logical criterion being that of consistency; but one is *not* at liberty to *add* assumptions, not contemplated by the author of a proposed system, nor can the latter be held responsible for contradictions or inconsistencies in consequence of the liberty

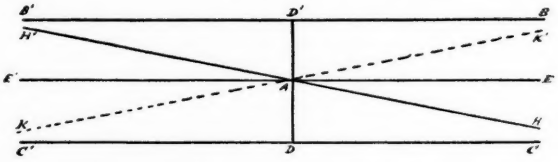
so taken. Now the geometry of Lobatchevsky consists in *replacing* Euclid's parallel postulate by an assumption which we may express thus: "Through a point not on a given line we can have more than one line not intersecting the given line," the system being, of course, co-planar. Any logical objection to the resulting system must not therefore assume the Euclidean postulate directly or indirectly by employing some theorem which is based on this postulate.

These considerations are evidently overlooked by the writer of "A Modern Zeno" in the April number of *The Monist*. For example, he says (page 294):

> "Now a right-angled isosceles triangle may be dissected into two other half size right-angled isosceles triangles by a line drawn from the mid-point of the hypotenuse to the vertex of the right angle...."

If the author can prove this statement without using Euclid's parallel postulate, or one equivalent to it, his demonstration will be by no means "an imputation upon the reader." If, as we are certain will prove to be the case, he finds it necessary to use this postulate, then he has *added* it unlawfully to the system of Lobatchevsky and is himself responsible for all resulting incongruities.

On page 301 he considers the following figure, where BB′ and CC′ are perpendicular to DD′, A being the mid-point of DD′ and AH a parallel to DC through A:



He shows (as is easily seen by symmetry) that AH′ || D′B′, and then shows apparently that

B′D′B || H′AH,
H′AH || C′DC,
and therefore B′D′B || C′DC.

He seems to overlook the fact that in the geometry of Lobatchevsky parallelism is a *sensed relation*, a fact apparent enough, however, in the author's own quotations, as for example,

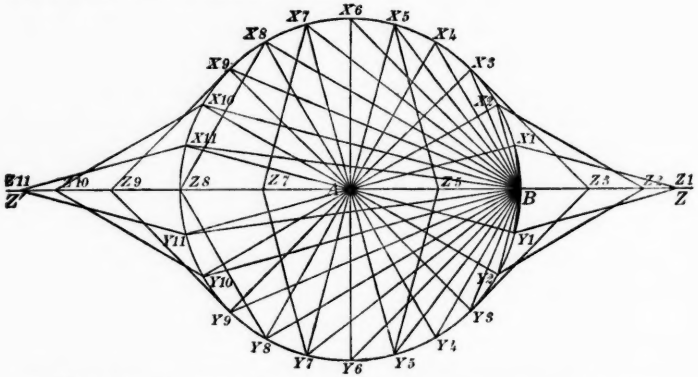
> "We must allow two parallels, one on the one and one on the other side" (page 292).
>
> "Under this assumption we must also make a distinction of *sides in parallelism*" (page 292).

"The farther parallel lines are prolonged on the side of their parallelism, the more they approach one another" (page 294).

In other words, if AH || DC, then AH is *not* parallel to CD. By keeping this in mind one can easily discover the fallacy of his course of deduction "no step of which is unsanctioned by the 'system' of Lobatchevsky" (!) by which he proves that in the above figure KAK′ is parallel to HAH′. These, among many other fallacies to which attention might be called, show that the author's criticism of the system of Lobatchevsky is not very formidable.

The author appears to be likewise unfortunate in his constructive work. In proposing a definition for a straight line, he says (pp. 304 and 305):

"Take any two points, say A and B. With, say, A as a turn-point (it might just as well have been B) and with the interval AB as the compass opening, scribe the circle BX_1X_2, etc. clear around complete. Then with B as turn-point and with *any* opening of the compass, short of 2AB, mark off on the first circle two points, say X_1 and Y_1. The same will be, of course, at equal intervals from B. Then from each of the points so marked scribe circles with the compass opening the interval AB. Such circles will all pass through A, but besides that they will otherwhere intersect and determine a point as, say Z_1" (Z probably stands for Zeno).

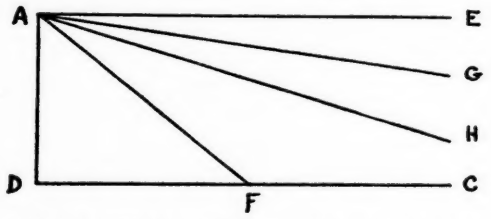


Now what is AB? A straight line segment (or *sect*, to use Dr. Halsted's happy term)? If it be a sect, then he is using a sect in defining the property of straightness! If it be not a sect, then what significance has 2AB? In speaking of the points X, Y, Z, he assumes (apparently unconsciously) that under certain conditions which he does not explicitly set forth, two circles may have two common points, but no more. The condition under which they have

only one common point is involved in his construction by circles centered at X_6 and Y_6, yet logically he cannot consider this important exception to his own statements. Again, in assuming that two circles cannot have three common points he is virtually assuming Euclid's parallel postulate with a few theorems included. The conditions under which they have two common points require for their consideration the definition of points within and without a circle, which definition requires a comparison of *sects*, the conditions involving in their ultimate analysis the assumption that a *straight line* through a point *within* a circle has one point (and therefore two points) in common with the circle! Also, the transition from an aggregate of distinct points (and these ununiformly distributed) to that of a continuous line is, if not impossible, at least quite difficult.

Another point which should be considered is that of simplicity in the initial assumptions; just as chemistry is founded on elements and biology begins with single cells, so geometry should have for its basis the simplest possible assumptions, each consisting, so far as possible, of a single statement. It was in all probability, the complexity of Euclid's parallel postulate, "If a Right Line, falling upon two other Right Lines, makes the inward Angles on the same side thereof, both together, less than two Right Angles, those two Right Lines, infinitely produced, will meet each other on that Side where the Angles are less than Right ones," which maintained interest in it, even if it did not afford the initial grounds for suspicion, rather than with regard to the relatively simple assumption which usually immediately precedes it, "Two Right Lines do not contain a Space." This simplicity which is in accord with the treatment of geometry by all modern critics is at variance with the course pursued by the author of the article in question.

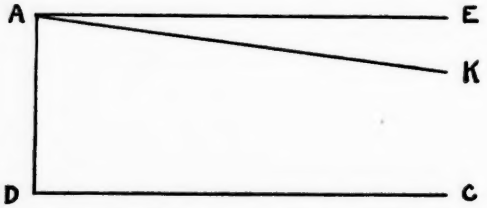
Again, referring to AH as the boundary of lines from A cutting DC, as AF, and not cutting DC, as AG, he says (page 297),



"But he definitely puts his parallel among the lines that do not cut. But how about the relation of that parallel to the next line, that is, the last of the

lines that cut DC? Does it make an angle with the parallel or is it the same line?"

Consider the same argument in connection with the following figure in orthodox Euclidean geometry, where AE and DC are perpendicular to AD and are therefore parallel. All other lines (or *rays*) in the angle DAE intersect DC. Let AK be "the last of the lines that cut DC. Does it make an angle with the parallel or is it the same line?....



"If the lines make an angle I suppose that that angle can be bisected, indeed *n*-sected, and such section-lines will be lines that neither cut nor non-cut. If the lines are only one single line then we have a line that both cuts and non-cuts."

Of course this argument is entirely fallacious, but it applies equally badly, nevertheless, to the geometry of Euclid and to Lobatchevsky. Other portions of the article are, of course, equally vulnerable.

G. W. GREENWOOD, M. A. (Oxon).

DUNBAR, PA.

Mr. F. C. RUSSELL STILL DEMURS.

To the Editor of The Monist:

I wish to thank the Editor for his considerate notice of my article "A Modern Zeno" in *The Monist* of April, 1909. I think, however, that he is in error as to my assumption of the straight line. It was my special and paramount solicitude to avoid that assumption, and it seems to me that I have succeeded. But a discussion of the points involved would make this reply too prolix.

I intended to make, and I thought I made, my article a distinct *plea for better information.* I judged myself an example of a numerous class who seem to themselves to have good geometrical faculty, and who are warranted in that persuasion by a body of confirmations independent of their own esteem, and yet who are per-

plexed and mystified as they study to understand the non-Euclidean doctrines. So I judged it to be eminently conducive to my purpose to exemplify in my article the manner and fashion after which such minds as mine are apt to conceive and deal with the elements of geometry. I hoped that my gropings would more or less reveal to the non-Euclideans the matter or matters at fault in my class of minds, and that some one or more of them would take the pains to so explain their doctrine as to put it within our compass.

I am a little surprised to observe that some of my critics presume a hierarchy in the domain of mathematics and would have the truths of geometry and the issues arising therein depend upon the authority of that hierarchy. Now while I am in no wise indisposed to defer largely to such an authority, I must protest that any blind subjection would outrage the crowning honor of mathematics, viz., that, unique among the sciences in that regard, it asks absolutely nothing on the ground of authority but appeals solely to insight and reason. Geometry, especially, walks by sight and not by faith.

Besides, the matters I agitate pertain to the very elements of geometry, and as to these how is it that the professional expert has, on account merely of his professional expertness, so much the advantage of the amateur? Of course professional expertness is an index of intellectual quality, but if other things be equal (an important condition truly) how is the professional expert better fitted to see more lucidly in dealing with the elements of geometry than any other person of good geometric faculty?

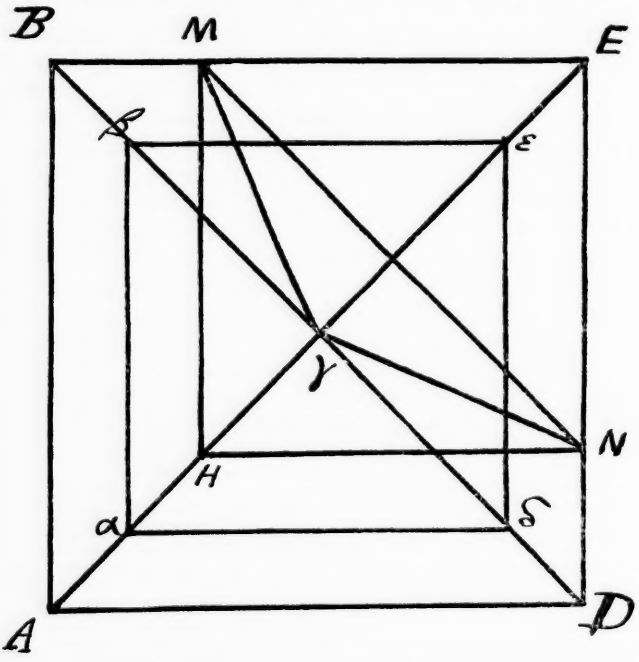
Since all of my professional critics have gone at once at that discourse of mine concerning the right-angled isosceles triangle I take it that my doctrine in that point is regarded as conspicuously vulnerable. I said in my article, "The proof that the two secondary triangles are exactly equal to one another, that they are right-angled and isosceles, and that the four tertiary triangles are in all respects precisely in the same case, is so simple in more than one way that it would be almost an imputation upon the reader to spread it before him." In saying this I was guilty of a mortifying inadvertance and of an unwarrantable presumption. Still, unless I am very, very sadly mistaken, the doctrine I laid down is quite sound and can be geometrically proved. So as a further exemplification of the geometrical inveteracies of such minds as mine I will now spread before the reader in detail what seems to me to be good geometrical proof of my proposition.

Consider and refer to the following figure.

Here are three quadrilateral figures ABED, $\alpha\beta\epsilon\delta$ and HMEN. They are really squares, but as yet we do not know that and so we will for the present call them *even rhombs*. (The word "even" will get its justification in due course.) ABED we will call the *outer* even rhombus, $\alpha\beta\epsilon\delta$ the *inner* even rhombus and HMEN the *corner* even rhombus. $\alpha\beta\epsilon\delta$ and HMEN are equal as we shall see. Each rhombus has two sets of triangles, for example, in the outer even rhombus ABED such triangles as ABE, BED, etc., to be called here its *major* triangles, and such triangles as AγB, BγE, etc., to be called here its *minor* triangles. So far all is loose preliminary, intended only as an aid in understanding the language I use.

The figure is constructed as follows:

Draw the straight line AαH$\gamma\epsilon$E and the straight line B$\beta\gamma\delta$D so that they intersect one another at γ at right angles. Take the



points α, β, ϵ and δ so that any one of the intervals $\gamma\alpha$, $\gamma\beta$, $\gamma\epsilon$ and $\gamma\delta$ shall be equal to any other of them. Join α and β, α and δ, ϵ and β, and ϵ and δ, by right lines. The four minor triangles $\alpha\gamma\beta$, $\alpha\gamma\delta$, $\epsilon\gamma\beta$

and $\epsilon\gamma\delta$ are made. Since any and every one of these triangles have been made right-angled and equal-sided about the right angle and any one side equal with any other, any one of the triangles is equal to any other of them, and hence any one of the sides $\alpha\beta$, $\alpha\delta$, $\epsilon\beta$ and $\epsilon\delta$ is equal to any other of them. Furthermore on account of the equality and isosceles nature of these (minor) triangles any one of the eight angles $\alpha\beta\gamma$, $\beta\epsilon\gamma$, $\epsilon\delta\gamma$, $\delta\alpha\gamma$, $\alpha\delta\gamma$, $\delta\epsilon\gamma$, $\epsilon\beta\gamma$ and $\beta\alpha\gamma$ is equal to any other of them. Since we do not as yet know how these angles last mentioned compare with the right angle, and since it will be necessary to have immediately a name for them we will for the present call such angles *u-angles*. These *u*-angles are not in any wise indeterminate. They are just as determinate as is the right angle, and they might be defined as being such angles as the sides of an isosceles right-angled triangle make with the hypotenuse. Only it is not yet determined how they compare with the right angle.

The angles $\alpha\beta\epsilon$, $\alpha\delta\epsilon$, $\beta\epsilon\delta$ and $\beta\alpha\delta$ being each and every one of them composed of two *u-angles*, are, on that account, as yet undetermined in their relations to the right angle, but they are indeterminate in no other respect. We will for the present call such angles *w-angles*. Any one of them is equal to any other of them. The four *major* triangles of the inner even rhombus, $\alpha\beta\delta$, $\epsilon\beta\delta$, $\alpha\beta\epsilon$ and $\alpha\delta\epsilon$, being each *w*-angles between pairs of equal sides, any one of which sides is equal to any other of them, are any one of such triangles equal to any other of them. The thoroughgoing evenness of the inner rhombus should now, I think, be abundantly manifest.

Now take A and E on the line AαH$\gamma\epsilon$E and B and D on the line B$\beta\gamma\delta$D so that any one of the intervals γA, γB, γE and γD shall be equal to either one of the (equal) sides of the inner even rhombus. Join A and B, A and D, E and B and E and D with right lines. Then there will be made an outer even rhombus with minor triangles, the sides of the rhombus, the angles of the minor triangles, the corner angles of the rhombus, the major triangles, etc., all equal homologously as in the inner even rhombus, such angles as ABD, BAE, etc., being *u*-angles and such angles as ABE, BED, etc., being *w*-angles.

Now take on BE the point M so that the interval EM shall equal the interval Eγ (or the equal interval $\beta\epsilon$, or etc.) and take on ED the point N so that the interval EN shall equal the same interval as above prescribed for the interval EM. Take on the line AαH$\gamma\epsilon$E the point H so that the interval EH shall equal the interval BE

(or the equal interval AB or etc.). Join M and N, M and H, M and γ, N and γ, and N and H with straight lines.

Now pursuant to Euclid I-V, MH equals Bγ which equals Eγ, either being equal to βε (or etc.) which equals ME which equals EN (or etc.), and pursuant to the same Euclidean theorem, NH equals Dγ which equals Bγ, etc., so that MH equals NH and so that any one of the four sides, MH, NH, ME and NE, is equal to any one of the others. Now the angle MEN being a *w*-angle equals the angle βεδ, while the sides of the triangle MEN, viz., ME and NE, are both equal to each other and either side equal to either side of the triangle βεδ. Hence the two triangles MEN and βεδ are equal. But the triangle NHM equals the triangle MEN (three-sides equal). Now the angles MHN and MEN have heen shown to be both *w*-angles, and since the triangle MEN is equal to the triangle βεδ it is further shown that the angle EMN which corresponds to the angle εβδ (or etc.) is a *u*-angle and that the angle ENM is also a *u*-angle is shown by a precisely like argument. But since the triangles EMN and HMN are equal, the angles HMN and HNM are also *u*-angles, so that the angles HME and HNE are shown to be *w*-angles. Now the triangles αβε and HME have the angles αβε and HME equal to one another (both being *w*-angles), which angles are in either triangle included between a pair of sides equal to each other and equal any one such side in either triangle to any such side in the other triangle. Hence the two triangles are equal and the side αε is equal to the side HE which was made equal to the side BE of the outer even rhombus. But it has just been shown that in the triangle αβε the side αε is equal to the side BE of the triangle BγE, and it was heretofore shown that the side Bγ (or Eγ) was equal to the side βε (or βα). Hence the triangle αβε is equal to the triangle BγE and the angle αβε homologous to the angle BγE is equal to the same. But BγE is a right angle. Hence the until now named *w*-angle αβε is now shown to be no other than a right angle, and its half, the until now called *u*-angle, is shown to be precisely half of a right angle.

The rest now goes almost of itself. In a right-angled isosceles triangle the acute angles are half right angles and equal to either one of the sections of the bisected right angle of the triangle. Hence in such a right-angled isosceles triangle the line from the vertex of the right angle to the mid point of the hypotenuse divides the primary triangle into two equal *isosceles* right-angled triangles, and the bisecting line is precisely one-half of the hypotenuse. Of course if

the above argument is sound the angle-sum of the right-angled isosceles triangles, at least, is precisely two right angles. If this is true I suppose it to be not very difficult to prove first that the angle-sum of *any* right-angled triangle is the same, and then that the angle-sum of any triangle is the same. There is very possibly some flaw in my course of argument. I can only say that up to the present time I have not been able to detect it.

It is objected against my remarks on the system of Lobatchevsky beginning about the middle of page 301, Vol. XIX of *The Monist* (April, 1909 number) that I have ignored the fact that Lobatchevsky distinguishes between sides in parallelism and that the statement of his Theorem 25 ought to be glossed by inserting the words "on the same side" in about the middle of that statement. Some of my critics make this gloss in their statement of said theorem. I avow that I honestly thought that the omission of the condition was deliberately designed by Lobatchevsky, for it seems to me that the reason of the matter justified the omission. Let us see. Lobatchevsky says in effect (Theorem 16—[*Monist*, Vol. XIX, pp. 291-292]) that in the uncertainty that obtains whether there may not be other lines than the perpendicular AE that do not cut DC, he will assume that such lines are possible, in plurality. The boundary line of such lines he takes as his parallel and, of course, makes it make the angle $\Pi(p)$ an angle less than a right angle. This leads him to remark that on the assumption he makes there will be two lines through the same point both parallel to the BDC line. This is *his* distinction of *sides in parallelism*, and it goes no further. As to such an idea as that two lines may be parallel if they are taken in the same *sense*, and yet *not* parallel if taken in opposite senses, I fail to find any vestige of it in Lobatchevsky's text. That would be to make Lobatchevsky's system a system of vectors instead of a geometry, and I am sure such a system as well as the idea of a *sensed relation* would put me to permanent intellectual confusion, should I endeavor to find any sense in either of them.

But Lobatchevsky, in his Theorem 17, stated thus, *"A straight line maintains the characteristic of parallelism at all its points,"* shows by his figure and demonstration that he had plainly in mind that a parallel was parallel as well on the other side of the $\Pi(p)$ line as on the one side. So I fail to see how my figure on page 301, April 1909, *Monist*, and my remarks in connection therewith ignore or violate any of the principles laid down by Lobatchevsky. I did not aver that he drew the consequences that I did. I plainly started

out with the remark, "But it is time to search for results ourselves," and it seems to me that I showed that the principles of Lobatchevsky lead to contradiction. At any rate, I cannot see how the distinction of *sides in parallelism* avoids the consequences I drew. It is true enough that Lobatchevsky, keeping (with the single exception I have mentioned) always on one side of the $\Pi(p)$ line, falls into no contradiction. With a parallel differing only infinitesimally from the ordinary parallel, and keeping always on the same side of the $\Pi(p)$ line, how could he fall into contradiction? It may be noticed in passing that Lobatchevsky makes nothing whatever turn upon any of the assumed plurality of lines that lie between his parallel and the perpendicular AE. It is probably of no consequence unless for the notice it gives us that so far as the system of Lobatchevsky is concerned there are no lines on the same side that pass through A that are of any consequence except the perpendicular AE and the parallel AH, the latter differing from AE by only an infinitesimal shade.

I cannot admit that my definitions of the straight line and the plane are amplifications of definitions previously published in Professor Halsted's *Rational Geometry*. Had I so esteemed them or either of them, I should not have published them as my own. It would be quite idle, however, for us two to dispute over the matter. We are both on record and whoever feels interest enough in the issue to inquire will decide irrespective of any clamor of ours. I may say, however, that definitions are a matter of words, apt for the publication of enough of the proper marks of the thing defined to make fully determinate all the other proper marks without making any use of the thing defined either expressly or by implication. I do not, as does Professor Halsted, make the straight line and the plane "aggregates of points." True, in leading up to my definition I make use of triads and aggregates of points. But when all is ready I drop those ideas and define a straight line as a certain kind of a *line*, and a plane as a certain kind of a *surface*, neither of which would I think of defining as an aggregate of points. As a matter of fact much of my method in geometry is the result of a practical business with linkages. Almost any one can see that my straight range is a virtual though mechanically unrealizable linkage. I may say that I have a linkage of thirty-seven links, any link of which is identical with any other link, with which linkage with two points fixed I can by continuous motion draw a limited straight line (in fact two) in line with the two fixed points. But this linkage did not

reveal the essence of the straightness of the straight line, as did the straight range. The latter is three-dimensional. The former only planar.

If it be asked what use can be made of my definition of the straight line, I can only say that I have not as yet found it of as much use in elementary geometry as I had anticipated. I can say, however, that it follows quite readily from the definition that two-intersecting straight lines can have only the intersecting point in common, and quite as readily that the straight line cannot return into itself; that is to say, that the straight line is infinite, a result which alone would sadly mar the symmetry of the non-Euclidean system.

CHICAGO, ILL. FRANCIS C. RUSSELL.

AN OPEN LETTER.

To the Editor of The Monist:

It was with great interest that I read your reply, in *The Monist* for July, to my article entitled "A Biochemical Conception of the Phenomena of Memory and Sensation" which appeared in the same number. It is not my intention to attempt anything approaching an exhaustive critique of the philosophical position which you assume, —an attempt which, as some four thousand years of sterile discussion have demonstrated, would be entirely useless. I am nevertheless constrained to draw your attention to certain points in which I am of the opinion that you have not represented my position, and that of a number of scientific colleagues, with that fairness which, I believe, we have a right to expect from the editor of a journal "Devoted to the Philosophy of Science." Since a charge of misrepresentation affects not only the accused, but also his readers, I have taken the liberty, Sir, of addressing you in the time-honored form of an "open letter."

In the first place, Sir, I must take exception to the style in which you have expressed yourself concerning my formulation of my hypothesis of memory in mathematical terms, and in which you have alluded to Professor Loeb's term "associative hysteresis," which he has proposed to substitute, in scientific literature, for the popular term "memory." I know that any suggestion that the mathematical or scientific author is seeking to "impress" or mystify his readers by the use of mathematical symbols or of scientific terms is welcomed by that type of general reader, who, with the common dislike of

humanity for concentrated and specialized effort of any description, is angered by the suggestion, which such terminology conveys to him, that there are problems which cannot be solved off-hand by virtue of a superficial acquaintance with the semi-popular literature of the subject,—that there are intellectual goals which cannot be won without effort,—or, to return to the instance in hand, that the recondite problems of brain-physiology, or, as you prefer to term it, psychology, cannot be solved by one who has not at least that degree of technical knowledge of the subject in hand which is required by the Artisan who would construct a steam engine. I recognize, I say, the literary effectiveness of your mode of expression, —but I deny its legitimacy. Your appeal to prejudice is unworthy of you, Sir.

But to return to questions less personal than that of controversial style.—On page 390 of your article you state your hypothesis of parallelism as follows: "There are not two separate factors, the psychological and the physiological, running parallel to each other, but there is one reality which has two aspects,—the one being the internal or subjective, the other the external or objective. The two are as inseparable and yet different as the internal and external curves of a circle." If I recollect my Euclid aright, a circle is a line which is without breadth, so that the internal and external curves are coincident and identical. Doubtless you will reply to this that I am pushing a material analogy to the extreme,—that I am taking advantage of an unavoidable imperfection of illustration. But I too am employing analogy, and my illustration of the difficulty which attaches to your theory is more pertinent than it may at first sight appear. What, I inquire, is the "one reality" to which you refer? In what does it differ from the "substance" of Spinoza? In what do the "two aspects" of the "one reality" differ from his "attributes"? Are they not merely the expression of that disparity between the extent of our "internal information" concerning our own cerebral states, and that of our information concerning the cerebral states of others, upon the origin of which I have dwelt in my article? To pursue our analogy further,—is there any space which separates the internal from the external curves of the circle, —and, if so, what is its content? I will refrain, however, from pursuing the metaphysical side of our discussion further,—metaphysical beliefs are so essentially temperamental in origin that the only logical end to such discussion, between courteous controversialists, is agreement to differ.

Your reminder that Professor Haeckel employed the expression "gaseous vertebrate" in reference to the anthropomorphic conception of the deity and not in reference to the dualistic conception of the soul was not, perhaps, wholly necessary. Professor Haeckel's works are well known and widely read, and it may be presumed that a writer does not quote such an expression without being perfectly aware of the connection in which it was employed by its author. Yet my extension of the phrase to include the dualistic conception of the soul is not, I venture to affirm, so inapt as you would appear to believe. I grant that the philosophers themselves have, perhaps, never represented the soul in this manner,—but then it is universally admitted that philosophers are men of exceptional intelligence. Would you seriously seek to deny that the dualistic conception of the soul, which is held by the rank-and-file of the uneducated and of the cultured alike, is not that of a "gaseous vertebrate, immanent within but independent of the material organism"? How, then, would you account for the belief in ghosts,—so generally denied, so universally entertained,—for the success of its fashionable expression,—the spiritualistic séance?

I am, however, constrained to call you to account for yet another and a more serious misrepresentation. On page 396 of your article you state that: "In spite of the merits of Professor Loeb especially in the line of physiological experiments, in which specialty he has distinguished himself, we can not see that psychology would be helped by calling some definite reactions which take place under some definite conditions 'tropisms.' We do not gain a scientific comprehension of these transactions until we gain an insight into the mechanism which upon a definite irritation causes organized life to move in a special direction and in a special way." While I, in common, I believe, with all my biological colleagues, heartily endorse the second of the above two sentences, it is possible that I share with a number of your readers an inability to perceive the precise connection between the two sentences,—or, I may mention in passing, the exact nature of the part played by "the merits of Professor Loeb" in the question under discussion. Do you really suppose, Sir, as your statement would appear to imply, that the term "tropism" is nothing other than a name employed by Professor Loeb to conceal lack of "a scientific comprehension of these transactions"? Since it is impossible to suppose that this implication is a deliberate attempt to misrepresent, one can only conclude that you are either unacquainted with the literature on the subject

of Tropisms, or else that you have utterly failed to grasp the significance of the evidence presented therein. True, the evidence is as yet, in the main, of a qualitative rather than of a quantitative character,—but we learn from your article that the "notion of quality" is "tolerated" by you, and this fact should therefore not deter you from perceiving that the investigations which have been carried out by Loeb and his pupils have at least carried us some way towards "an insight into the mechanism which upon a definite irritation causes organized life to move in a special direction and in a special way";—that they have shown that these movements can be controlled by physical and chemical means and are therefore, in all probability, the expression of physical and chemical occurrences within the organisms; and, finally, that they have shown that many of the more complex reactions which we term "instincts" are analysable into simpler elements which are tropisms, i. e., controllable by physical and chemical means. If, indeed, you do not perceive in Loeb's theory of tropisms anything other than an empty nominalism,—it is regrettable, but it does not deprive the theory of its value, even in the exclusive domain of psychology. You will recollect Wordsworth's character of whom it is said:

> "A primrose by the river's brim
> A yellow primrose was to him,
> And it was nothing more."

It is usually conceded that these words were not intended to imply default on the part of the primrose,—I leave the further pursuance of the analogy to you, Sir.

Abandoning, however, the language of metaphor (although, Sir, in view of your artistic reference to the Sistine Madonna, I may be pardoned my short excursion into the realm of poesy), and returning to the more prosaic vocabulary of scientific discussion, I venture to insist that a statement of a theory is not, in itself, adequate evidence of its validity. It is a simple matter to propound theories, Sir, but it is quite another matter to apply to them the test of fact,—indeed it is for this reason that philosophies and religions are so incomparably more popular than science.

In objecting to a theory which is supported by experimental evidence the burden of proof is thrown upon the objector,—he is expected, in scientific discussion, to demonstrate that the theory to which he takes exception is insufficient, and, if at the same time he advances a theory of his own, to demonstrate, not only that his theory is sufficient where the other is insufficient, but that it is also

in agreement with the facts upon which the opposing theory was based. In your article I find a statement of a theory of memory, which regards this phenomenon as an expression of "the preservation of living forms," and I find it stated that my theory of memory is inadequate. Yet I am unable to ascertain from your article what are the facts with which you support these statements. I find, in your article, statements based upon statements, and I find hypotheses evolved from preconceptions, but I do not find statements based upon facts.

Finally, Sir, I may be permitted to draw attention to the misleading nature of your dictum that "Professor Robertson's reduction of this statement to a mathematical formula, $\log n = Kr + b$, where n is the number of syllables memorized, r the number of repetitions, and K and b are constants,. . . .adds nothing to the explanation of the phenomenon itself." While it is perfectly true that the mathematical formulation of an hypothesis adds nothing whatever to the content of the hypothesis, yet when that mathematical formulation is applied to quantitative measurements, and the identity between the demands of theory and the facts of experiment is established, then much is added to the "explanation of the phenomenon itself," for the validity of the hypothesis is rendered proportionately the more probable. Quantitative evidence differs in no respect from qualitative evidence, save in the fact that the qualities compared are expressed in numerical units; but since the acquisition of qualitative must necessarily precede that of quantitative evidence, our knowledge of a phenomenon is the more complete the more it assumes a quantitative character.

T. Brailsford Robertson.

University of California.

DR. EDMUND MONTGOMERY.

Dr. Montgomery is a unique figure in the philosophical world. Having been a prominent member of the Concord School, he belongs to the history of this country, though he has contributed voluminously to the periodicals of the Old World, and is credited with having blazed new paths into biological fields.

By descent, Scotch; by birth, English; by education, German; by residence, American, Dr. Montgomery's life has been more than ordinarily eventful; yet he wrote recently in response to a request for autobiographical data: "Long ago I resolved that if a call should

come during my lifetime to furnish notes concerning my personal history, I should ask permission to keep silence with regard to everything not directly connected with my work. I think that with the exception of very eventful careers, run by extraordinary characters, it is inflicting a grievance on the reading public in these crowded times to thrust one's personal matters upon their attention. It would not greatly disappoint me to learn that my name and personalities would not long be remembered; but it would discourage me to learn that after close examination my biological researches and my thoughts proved not to have probed deeper, a little deeper than hitherto, the secrets of life and nature."

At Frankfort young Montgomery participated enthusiastically in the German Revolution of 1848-9, following with absorbing interest the parliamentary discussions, and eventually taking active part in the building and defense of the barricades. It was here, too, he experienced struggles with the problems of religion which drove him almost to suicide. Susbsequent years brought him into intimate relations with many of the world's foremost workers in science and philosophy.

While on the Medical Staff of St. Thomas' Hospital in London, and in consequence of a dissecting wound, his lungs became effected. Residence in a milder climate seemed imperative. He went, therefore, greatly dejected, to Madeira. There his medical practice increased overmuch, and placed too great a tax upon his strength. Again changing residence, he went to the Riviera and eventually to Rome. But tiring of having no settled home, he harkened to the call of the new world, whither friends, similarly afflicted and instigated with the same ideals had preceded him, sending back most encouraging reports. In the year 1873 he purchased the Liendo Plantation near Hempstead, Texas, where he has ever since lived, enjoying until lately good health, and devoting himself to his cherished biological researches and philosophical studies.

His wife was the well-known sculptor, Elizabet Ney, whom he first met in his school-days at Heidelberg, and whom he married at Madeira in 1863. Together they shared the joys and sorrows of life, engaged in their separate fields of labor, until June 1907, when the artist-wife, after an illness of about one month, died of heart disease. In October of that year an article by Mrs. Bride Neill Taylor appeared in *The Open Court* which gives a detailed account of the life and work of this famous artist, and is accompanied with illustrations of her most notable works of art.

Dr. Montgomery worked out his philosophy in a period when metaphysicism was confronted with materialism, and no middle ground was recognized. Being a physician by profession, and having specialized his work in physiology, Dr. Montgomery was too much of a naturalist to accept the idealistic horn of the dilemma, while, on the other hand, he was too well acquainted with the insufficiencies of naturalism to fall a prey to materialism. So he steered a middle course and found a solution of the world-riddle in "vital organization." His solution consisted in pointing out, with much attention to detail, the mystery of mysteries which is the wonderful activity of purpose-endowed life with its powers of choice and self-adaptation; and so it was but natural that his whole philosophy is tinged with a poetical mysticism.

The matured fruit of Dr. Montgomery's life has appeared of late in a stately octavo volume of 462 pages, entitled *Philosophical Problems in the Light of Vital Organization*, and we deem it proper to have a summary of the work presented by a man who, for more than twenty years, has been an ardent admirer of the Scotch-German-American hermit-philosopher of Texas. We cannot help thinking that Dr. Montgomery's solutions of the several problems are often unsatisfactory, however elegantly they may be worded. They discuss, but do not adequately answer the questions presented, and sometimes read more like prose poems than philosophy. But he assigned himself large tasks, tasks that involved intellect of an unusual type—the periscopic sweep of the pansophist and the thoroughgoing patience of the scientific specialist. *In magnis voluisse sat est.* So Dr. Montgomery is a remarkable figure, and as we do not mean to restrict the pages of *The Monist* to our own type of thinking, we gladly welcome to our columns a presentation of Dr. Montgomery's philosophy of "vital organization." EDITOR.

MALAY NOT ACCEPTABLE.

To the Editor of The Monist:

There are one or two points in your remarks in the July *Monist* where in my opinion you seem to err. You consider the present situation as a good parallel to that when Volapük fell. It is a parallel in one way, but a counterpart in another. The Volapük reformers did have to create an entirely new language, on a basis vastly different from Volapük. It did, of course, take them many years to bring out "Idiom Neutral," and in the meantime they could not but lose the great public. *Now*, the public is simply invited to choose

between two ready made dialects which are so similar that the transition can be made after an hour's study. The main idea is that many arbitrary features have been removed, and international ones, known to everybody, substituted. Both Ido and Esperanto recognize exactly the same principles, theoretically. In one sense the strenuous opposition of the Esperantists (which is much more vigorous than was that of the conservative Volapükists) is a good sign, even for the Idists. It proves that if even a language with relatively large imperfections can take root so strongly with many, Ido will, after it has overcome this resistance, be well-nigh proof against all attacks and further reform attempts, so far as they shall concern more than trifles. It may take a few years time to get there; but then things will settle down to a state of great relative stability.

As to Malay: are you not afraid that *The Monist* would look *a little* queer in that tongue? Have the Idists deserved a suggestion of *that* caliber, or are you in earnest in imagining that the European-American world would be inclined to relinquish the forms of thought that have come to them in two thousand or more years of history? You said something at a time about "*improving living* languages," and we are trying to present the quintessence of western European speech, with everything *a priori* strictly excluded. Between modern English, modern Malay, and an unheard-of though ingenious pasigraphy you seem to have touched several of the possible extremes: what's the matter with a scientifically constructed *a posteriori* tongue *as a compromise?* O. H. MAYER.

EDITORIAL REPLY.

In reply to Mr. Mayer's questions, I will say that probably the European-American world will not be any more "inclined to relinquish the forms of thought that have come to them in two thousand or more years of history," for the sake of Malay than for Esperanto or Ido. I believe that they will simply go on improving their own speech and world language will thus develop in the natural way. An artificial language should in my opinion not reject the *a priori* elements, but on the contrary should be based on them. It ought to be an algebra of thought constructed *a priori,* and the *a posteriori* meaning ought to be inserted just as in mathematics algebraic symbols whenever applied receive a definite meaning. Upon the whole we may leave the formation of an international language to its fate and watch the efforts of those who try to construct it artificially with critical sympathy.

BOOK REVIEWS AND NOTES.

LETTERS TO CASSITE KINGS FROM THE TEMPLE ARCHIVES AT NIPPUR. By *Dr. Hugo Radau, Ph. D.* Price $6.00. Royal quarto; paper covers.

This is marked Volume XVII, part 1, of the Cuneiform Texts of the Babylonian Expedition of the University of Pennsylvania; and in it Dr. Radau gives us 190 pages of preliminary discussion and notes, and 80 beautifully engraved plates and photogravures of 131 cuneiform texts from the archives of the temple of En-lil at Nippur in Babylonia.

The Cassite dynasty of Babylonian kings reigned for nearly 600 years; from 1814 to 1238 B. C. according to the chronology favored by Assyriologists. And yet their exact racial origin is still undetermined. They were certainly neither Sumerians nor Semites, as the character of their names sufficiently indicates. Their especial title was "King of Karduniash," a name that still awaits explanation. The most likely guess identifies them with the Kossaeans of the Zagros river, while their original home was, some say, in Northern Elam, and others even suspect Hittite affiliations.

But although Babylon was their chief and capital city, yet Nippur was ever their favorite residence; and the official title which they most greatly valued was that of *shakkanakku Enlil,* or "Lord Chancellor of the god Enlil." All transactions of and for the Temple needed their seal [*kanaku*] to be legal, so that every Cassite ruler was also, in a special sense, the High-priest-king of Nippur.

Furthermore, the period during which these tablets were written, namely 1440 to 1320 B. C., was a most vital epoch. For then, for the first time so far as we know, Babylonia came into communication with age-old Egypt on the one hand, and was attacked, on the other hand, by the newly rising power of Assyria, to this time belonging the famous Tel-el-Amarna cuneiform tablets of Amenhotep III and IV. The Berlin museum has three letters of the Cassite Kadashman-Bel to Amenhotep III; and 4 letters of Burnaburiash II, the son of Kadashman-Bel, to Amenhotep IV (the heretical Khu-en-Aten), the son of Amenhotep III, while the British Museum has a cuneiform tablet written by Amenhotep III to Kadashman-Bel; and two written by Burnaburiash to Khu-en-Aten.

Then, we have in 1421 B. C., the punitive invasion of Babylonia by Asshur-uballit, King of Assyria, for the purpose of avenging the assassination by the rebellious Cassites of their king Kara-Hardash (or Kadashman Harbe), the husband of Muballitat-Sherua, the Assyrian King's daughter; and of seating upon the Babylonian throne Kuri-Galzu II, their young son and heir, who was the Assyrian King's grandson, the temporary Cassite usurper Nazi-Bugash being either driven out or slain.

This is the first evidence, with the two exceptions yet to be noted, of the existence of Assyria, hitherto apparently a mere vassal colony, but destined to grow ever more powerful for the ensuing 800 years. The only evidence of any earlier contact is found, first, in the "Synchronistic History" from Asshurbanipal's library, wherein it is stated that nearly nine centuries previous, in 1500 B. C., a treaty had been made between Asshur-bel-nishishu, King of Assyria, and Kara indash, the "king of Karduniash"; this latter being also the as yet unexplained title employed for Cassite rulers in the letters of Amenhotep III and IV, previously noted.

And the other mention of Assyria is in the tablet, also noted above, in which Burna-Buriash writes to Amenhotep IV, warning him against encouraging in their plots the Assyrians, "my vassals."

The tablets under review, however, published by Dr. Radau, and written, as their title states, *to* and not *by* Cassite kings, deal with no such lofty themes as international history or diplomacy. On the contrary they are merely business documents from the Nippur temple archives, many of them nominally or formally addressed to the sovereign, as the titular chancellor—while practically they are merely requisitions for urgently needed supplies from the surly and parsimonious Head-Bursar of the temple. Other letters, again, are reports by generals, architects, or physicians of the temple, and all ranging in their dates from the reign of Burna-buriash II (1440 B. C.) to that of Shagarakti-Shuriash (1320 B. C.) and Kashtiliashu (1309 B. C.)

Extremely useful tables of the masculine and feminine names, and those of places, gods, etc., etc., occurring in the tablets, close Dr. Radau's introductory text. And then follow the 80 finely engraved plates and photogravures, showing in all 131 inscriptions; so that, manifestly, the publication is designed, like the others in this series, not for the general reader, but rather for the student and expert in Sumerian andAssyriology.

And to such a one Dr. Radau's exquisitely clear transcriptions of the texts will surely be of the utmost value. Those who have at any time endeavored, with straining eyes and befogged brain, to identify—let alone coherently read—even a few of the signs upon one of these overcrowded and wellnigh illegible half-baked or unbaked clay tablets, will appreciate to the full the vast labor Dr. Radau has undergone, and the great amount of eye-strain, temper, and time, the subsequent student is spared.

Indeed in the tablets themselves we have an amusing illustration of their inherent difficulties and obscurities even to the men who wrote and used them, for one writer, about 1370 B. C., dejectedly complains that he had requested "earthen pots," but his correspondent had misread, and sent him "*straw*"!

Now if an old Babylonian of 33 centuries ago could make such a blunder in his own script; surely we alien scholars of so widely different a race and age, can be pardoned if we too occasionally err.

In closing we may note that the dates for the Cassite dynasty adopted by Dr. Radau and Assyriologists in general, are earlier, by about 50 years than those favored by Egyptologists, who give either 1383 to 1365 B. C., or 1377 to 1361 B. C. as the date of Amenhotep IV; thus making Burna-buriash II, who was his contemporary for seven years, reign from about 1401 or 1395 to 1376 or 1370 B. C., in place of 1440 B. C., as preferred by Assyriologists.

Dr. Radau, the author, Dr. Hilprecht, the editor, and the University of

Pennsylvania are all to be warmly congratulated on this addition to their series. For it will be an enduring monument to the ripe scholarship of Dr. Radau and of his mastery of the exceedingly difficult script, languages, and history of early Babylonia.

ALAN SPENCER HAWKESWORTH.

HISTORY OF THE MEDIAEVAL SCHOOL OF INDIAN LOGIC. By *Satis Chandra Vidyabhusana.* Calcutta: Calcutta University, 1909. Pp. 188.

This is a pioneer work in so far as the author has scarcely any predecessors in the field of Indian logic. Buddhist logic has been treated by several scholars, but for his sources of the Jaina logic he has to fall back mainly on unpublished and unedited manuscripts scattered all over Western India and the Deccan, and also preserved in some libraries. The book would have been more useful to Western people if he had considered the general ignorance of Sanskrit which prevails outside of India. A Western reader will probably be deterred from venturing into further study of the book if he reads the first sentences: "Logic is generally designated in India as Nyaya-shastra. It is also called Tarka-shastra, Hetu-vidya, Pramana-shastra, Anviksiki and Phakkika-shastra." (We here replace in this quotation the accented "s" by "sh.")

Since the book is meant for Sanskrit scholars this is scarcely a drawback, but we would suggest to the author if in a future edition he would feel the need of elaborating his work, to take into consideration also the uninitiated who are willing and anxious to learn. The book is very scholarly and is a new evidence that the Hindu race has worthy representatives who are well-trained thinkers. The book is divided into two parts: (1) The Jaina Logic, pages 1 to 55, and (2) The Buddhist Logic, pages 57 to 144. Three appendices contain some historical notes about the university of Nalanda (about 300 to 850 A. D.), and the Royal University of Vikramasila (about 800 to 1200 A. D.)

DIE DREI WELTEN DER ERKENNTNISTHEORIE. Von *Dr. Julius Schultz.* Göttingen: Vandenhoeck & Ruprecht, 1907. Pp. 104. Price, 2.80 m.

Dr. Julius Schultz is a philosophical author who writes in a popular and sprightly style. In criticizing the views of others he employs sometimes the weapon of humor without however yielding to malevolence. He points out that the philosopher starts with the data of experience, but the question is, what are these data? The logician declares that thought is given; the sensualist, sensation; and the empiricist, the naive world-conception of man. Dr. Schultz shows that a point commonly overlooked is the question, to whom are the data given; for the same object may be different to different observers. The first world of which he speaks is the empirical world, which has to be analyzed through the forms of thought, or as Kant would say, the categories. The second world is truth, and the object of the second world, matter. The third world, when trying to attain to ultimate certitude, is not, as Descartes says, *cogito* or the "I think," nor is it as his critics would say, *cogitat,* an impersonal thinking, but the imperative *cogita.* The last certitude is the content of every moment. It is the psychical expansion of our life, or as Dr. Schultz expresses it in his native and untranslatable German, *das Erlebnis des Erlebens.*

Our author lacks perhaps the method of a trained philosopher, but his mode of treatment is nevertheless interesting because he is possessed of common sense and is entertaining even where his ultimate thought is still subject to criticism.

SEMITIC MAGIC. Its Origin and Development. By *R. Campbell Thompson.* London: Luzac, 1908. Pp. 283. Price, 16s. 6d.

This volume forms a very interesting contribution to Luzac's Oriental Religions Series. The theories contained in it are based on a most careful study of the development of demonology in Western Asia from the time of the cuneiform incantation tablets through the periods of rabbinical tradition, Syriac monkish writings and Arabic tales down to its present survival in modern Oriental superstition. Studied in connection with the parallels offered by Aryan and Hamitic notions, these superstitions combine to throw light on the origin and significance of many of the peculiar customs of the Old Testament. The author divides his subject in the light of certain deductions gleaned from a particular study of the characteristics of the evil spirits which the Semites believed to exist everywhere. These deductions, bearing on the primitive systems of tabu, are as follows: (1) all evil spirits could inflict bodily hurt on men; (2) the relations between human beings and either evil or divine spirits were close enough to allow of intermarriage; (3) from this belief in intermarriage with spirits originated the sexual tabus; (4) since a man might suffer from an unwitting tabu it was necessary to exorcise the demon by transferring the evil influence to some external object; (5) from this idea arose the atonement principle and idea of sin offering; (6) from this stage would naturally arise the substitution of sacrificial animals for the first born.

The book is furnished with a careful and detailed index, followed by a list of Biblical quotations.

THE BURMESE AND ARAKANESE CALENDARS. By *A. M. B. Irwin.* Rangoon: Hanthawaddy Printing Works, 1909. Pp. 92. Price, 5s. net.

This book serves as a second edition to "The Burmese Calendar," published in 1901, but the author states in his preface that he has been able so to complete by further researches his former work that he is fully justified in giving it a new title. This is made necessary by including the Arakanese calendar together with the Burmese. The book is carefully prepared, the author's object being to make it intelligible and useful to both Europeans and Burmans. Mr. Irwin first describes the calendars as they are, next he shows certain errors in these calendars and points out their cause, suggesting also some alterations. The last part of the book consists of tables by the aid of which English dates may be changed into Burmese and *vice versa.* Tables I to III cover a period of 262 years, table I serving for past years and the others for the future. Table IX supplies the means for changing any date within these years from one calendar to the other.

HINDU TALES. Translated by *John Jacob Meyer.* London: Luzac & Co., 1909. Pp. 305. Price, 8s. 6d.

This volume is an English translation of the *Ausgewählte Erzählungen* of Jacobi, to whom the author dedicates his work. With regard to the interest

of the stories here collected the translator sums them up in his preface with the following criticism: "The first story in the following collection is decidedly the poorest—a most insipid and tiresome performance. The tales increase in interest as we go along. The novella of Muladeva, which comes toward the end of the book, will fascinate many a reader. From the literary and from some other points of view the best of all these selections is the last —the poem of Agadatta. So I hope the general reader will not despair when he is confronted at the very outset by that wooden statue of a sensualist called Bambhadatta. The student will find much valuable matter in all the stories."

ETUDES SUR LÉONARD DE VINCI. Par *Pierre Duhem*. 2. ser. Paris: Hermann, 1909. Pp. 473. Price, 15 fr.

This second series of studies on the most versatile of Italians, consists of four parts, of which the first treats of Leonardo da Vinci and the two infinites, the infinitely great and the infinitely small. The second part discusses his relation to the plurality of worlds. The third compares him with Nicholas de Cues, that philosopher of the Middle Ages who in his liberality of thought was virtually not a Mediæval philosopher at all, but an over-conservative modern. The fourth part deals with Da Vinci and the origin of geology.

L'ANNÉE BIOLOGIQUE. Comptes rendus annuels des travaux de biologie générale. Publiés sous la direction de *Yves Delage*. Paris: Soudier, 1909. Pp. 508.

The 11th number of this valuable annual has come to hand. It gives a comprehensive survey of all the work done in the biological field in the year 1906. Its preliminary essay is on *Les colerations vitales*. It reviews work along 20 special lines as divided in as many chapters, and each of these chapters contains discussions of perhaps 50 authors and their publications in magazine and book form. Thus specialized the annual is of invaluable service to the specialist in any branch of biology, whether he is most interested in the cell, fertilization, ontogenesis, heredity, variation, or any other of the 20 main subjects included.

BIOLOGY AND ITS MAKERS. By *William A. Locy*. New York: Henry Holt & Co., 1908. Pp. 469.

In this volume Professor Locy undertakes to bring under one view the broad features of biological progress, including not only the various phases of the evolution theory, but also the other features of biological research, some knowledge of which is essential to an intelligent comprehension of the former. He has endeavored to increase the human interest by centering his story around the lives of the great leaders in the various movements. The book is divided for convenience into two sections. In the first are considered the sources of the ideas that dominate biology, while the doctrine of organic evolution on account of its importance is reserved for special consideration in the second section. The text is illustrated very fully with portraits. Some of the rare ones are unfamiliar even to biologists, and have only been discovered after a long search in the libraries of America and Europe. The first

chapter treats of the origin and history of biology in general. Then follow chapters on Vesalius, Harvey, the pioneer microscopists, the minute anatomy of the 18th Century, Linnæus, Cuvier, Von Baer and the rise of embryology, the cell-theory, protoplasm, Pasteur, the theories of Mendel, Galton and Weismann on heredity, and fossil life. In the second part evolution is defined and the various theories of Lamarck, Darwin, Weismann and De Vries are discussed in detail.

The following books have been received at this office:

Dr. P. Häberlin, *Herbert Spencers Grundlagen der Philosophie*; eine kritische Studie. Leipsic: Barth, 1908. Pp. 205. Price, 5.40 m.—Josef Popper, *Voltaire*, eine Charakteranalyse, in Verbindung mit Studien zur Aesthetik, Moral und Politik. Dresden: Carl Reissner, 1905. Pp. 388.—Josef Popper, *Fundament eines neuen Staatsrechts*. Dresden: Carl Reissner, 1905. Pp. 86.—Charles S. Myers, *A Text Book of Experimental Psychology*. New York: Longmans, Green & Co., 1909. Pp. 432.—Wilbur Marshall Urban, *Valuation, Its Nature and Laws*: Being an Introduction to the General Theory of Value. London: Swan Sonnenschein & Co., 1909. Pp. 433. Price, 10s 6d.—William Wilberforce Costin, *Introduction to the Genetic Treatment of the Faith-Consciousness in the Individual*. Baltimore: Williams & Wilkins, 1909. Pp. 45. Price, 65 c., mail, 71 c.—Raymond Weill, *Les origines de l'Egypte pharaonique*. 1re partie, "La IIe et la IIIe Dynasties." *Annales du Musée Guimet*. Paris: Leroux, 1908. Pp. 510.—Edward Bradford Titchener, *A Text-Book of Psychology*. New York: Macmillan, 1909. Pp. 311. Price, $1.30.—Charles Gray Shaw, *The Precinct of Religion in the Culture of Humanity*. London: Swan Sonnenschein, 1908. Pp. 279.—Dr. Berthold Kern, *Das Problem des Lebens* in kritischer Bearbeitung. Berlin: August Hirschwald, 1909. Pp. 592.—Arnold Reymond ,*Logique et mathématiques*; Essai historique et critique sur le nombre infini. Saint-Blaise: Foyer Solidariste, 1908. Pp. 218. Price, 5 fr.

We are glad to welcome Volume IV of the New Schaff-Herzog Encyclopedia of Religious Knowledge which proves to be a monitor of the passing of time as it marks the end of another three months with the precision of the calendar. Its range is from "Draeseke" to "Goa." It contains articles of interest in archeological, historical, biographical and purely religious subjects treated by specialists. A few suggestive headings are Duns Scotus, Erasmus, Dunkers, Eastern Church, Egypt, France, Society of Friends, Eden, Ecstacy, Faith, Gesenius. This volume is also furnished with a bibliographical appendix which brings bibliographies for the articles contained in all four volumes, down to July, 1909.

The collected works of A. Spir, edited by Helene Claparède-Spir, are now complete in two volumes. (Leipsic: Barth, 1909. Pp. 390, Price 8 m.) The second volume which has just appeared contains his essays on "Morality and Religion" and "Right and Wrong," besides some lesser miscellaneous writings.

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Alfred Binet. 20c. (9d.)

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